

Phelsuma

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NOTES

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EDITORIAL

This issue of *Phelsuma* highlights a number of important advances in our understanding of the biology of the region. Such advances require sound taxonomic frameworks to support theories and observations; as with last year's issue taxonomic revision continues with the exemplary work of M. Saaristo on Seychelles spiders. Such a taxonomic framework allows the identification of important, but easily overlooked, processes as is described in the paper on the extinction of a snail species through hybridization. This apparently natural event demonstrates the dynamic nature of ecology and evolution. Dynamic change of a less natural nature is shown in the account of ecological change in areas dominated by invasive plant species and by the presence of 'Takamaka wilt' disease. In addition to the information gathered by repeated observation of specific taxa and localities, important new discoveries of new and overlooked species continue to be made. Last year saw the rediscovery of an 'extinct' giant tortoise, this year sees the rediscovery of the plant *Impatiens gordonii* on Silhouette, bringing the total known number of plants of this species from 2 to several hundred in one of the most exciting botanical discoveries in recent years. In this issue the geology of Silhouette is elaborated, putting a regional and historical context on what is now recognised to be biologically the most important of the granitic islands. Further rediscoveries on Silhouette are reported, including the location of important roosts for the sheath-tailed bat *Coleura seychellensis*. Another rediscovery is that of the endemic Seychelles terrapin *Pelusios seychellensis*, last seen in 1894.

The rediscoveries reported in this issue are the result of exploration of new areas and of chance encounters. The general increase in such findings in the last five years is due, in part, to more thorough exploration, but may also reflect wider changes. One of the notes discusses the effects of climatic cycles which probably affects the populations of many species. Such population changes may be reflected in the collections made between 1866 and the present day. The material in these collections is broadly similar but there are notable absences from some that are not entirely explicable by consideration of the localities visited as fluctuations in abundance are apparent even within the same locality. Collections made by Alluaud, Brauer, Van Mol & Benoit and the post 1990 collections were all from wet phase years whilst the Percy Sladen Memorial Expeditions both took place during switches between wet and dry phases. This latter expedition collected many species not located before or since and failed to locate several apparently common species, despite the most thorough collecting in the history of the region. This may indicate that collections reflect climatic conditions and several species that we have come to consider as rarities may increase in abundance in the current wet phase. Corresponding declines in many species that were familiar in the 1974-90 dry phase are to be expected. The continued monitoring of change apparent in a number of reports in this issues of *Phelsuma* should yield fascinating insights into such processes in the near future.

CHAIRMAN'S REPORT

A greater awareness of the value to the environment of non-government organisations like the Nature Protection Trust of Seychelles has led to more and more demands on our time. Invitations to be represented on government committees, to attend seminars and workshops, have flooded in this year. As we are an organisation of volunteers, it is often difficult to fulfil these important requests. Some delegation of responsibility has been made as in the case of our representation on the National Environment Council by Dr. Maureen Kirkpatrick.

This year the Secretary and I have devoted a great deal of our time to fund-raising. In the current difficult financial climate, funds are not easy to attract, especially when the government's own Environment Trust Fund holds all the cards. Their ability to offer two hundred percent allowance against tax to corporate sponsors cost us all our sponsor members in 1995 and 1996. Despite our status as a non-profit-making organisation, the Ministry of Finance has refused to allow us to offer this same incentive of tax relief against company donations. We must now rely entirely on overseas funding.

Local sponsor members are now more likely to offer something in kind rather than financial support. We wish to thank the following companies for their continued assistance:

Air Seychelles for concessionary air fares for project members

Seychelles Breweries for layout and design of "Birdwatch" and financial assistance, through the government's Environment Trust Fund, to the Seychelles Giant Tortoise Identification Project

Seychelles Petroleum for the use of their boat "Lady Dorothy" to visit the Silhouette Conservation Project

In January 1996, we were awarded two grants by the Royal Netherlands Embassy under their "Special Activities Fund". The first grant has enabled us to increase the print run on both our publications. The second grant will enable us to undertake our first major project on Silhouette. We will clear the paths between La Passe and Grande Barbe and La Passe and Anse Mondon, paying attention to erosion problems and re-routing the path away from sensitive areas containing rare plants.

The Silhouette Conservation Project will get under way in June. Our office will be located in the old plantation house which is known as the Grande Case. The use of the Grande Case as a research station was made possible by Mr. G. Savy, Executive Director of the Islands Development Company, who has overall responsibility for Silhouette. We will continue to attempt to raise funds for a purpose built research station. Support for the Silhouette Conservation Project has

CHAIRMAN'S REPORT

been obtained from the Division of Environment in Seychelles, thus ensuring the future of Silhouette.

As a result of a decision taken at our last AGM, we have applied for membership of the International Union for the Conservation of Nature. The aims and objectives of the NPTS conform with those expressed in the IUCN's "World Charter for Nature", and membership will enable us to participate in the wider conservation movement through contacts with other conservation bodies.

The various research projects initiated this past year are detailed in this volume of "*Phelsuma*". The major research project of the year was undoubtedly the investigation of captive tortoise herds on the granitic islands. Blood samples taken from 60 animals have been sent to Aberdeen University where the DNA will be analysed in order to identify any extant granitic island specimens.

A project aimed at producing a Seychelles Red Data Book was initiated in 1995. This involved the establishment of a Scientific Committee, which is described below. We have submitted the Red Data Book project to the Royal Netherlands Embassy with a request for funding under their Special Activities Fund.

In conclusion, I should like to express the hope that our membership of IUCN, our wider involvement in conservation with the Silhouette conservation Project and our participation in the projects of other bodies will encourage members to take a more active role in the future. We need your active support if the NPTS is to continue to fulfil its aims efficiently.

NPTS SCIENTIFIC COMMITTEE

The Scientific Committee of the Nature Protection Trust of Seychelles was established in 1995 to advise the NPTS on the scientific basis of conservation measures, to determine research and conservation priorities and to review proposed research projects. The Committee comprises 12 members selected for their specialist expertise or relevant experience covering geology, genetics, botany, zoology (with specialists on insects, molluscs, arachnids, amphibians, reptiles and birds), marine biology, tropical ecology and habitat restoration.

The Scientific Committee has redrafted the Silhouette Management Plan and is preparing a Seychelles Red Data Book which will be a useful tool in identifying areas of concern and in setting conservation priorities for all islands within the Seychelles group (including the Amirantes and Aldabra group).

Annual reports of the Scientific Committee will be summarised in future issues of *Phelsuma*.

Committee chairman:

Dr. J. Gerlach (Nature Protection Trust of Seychelles)

Committee members:

Q. Bloxham (Jersey Wildlife Preservation Trust)

I. Bullock (Royal Society for the Preservation of Birds)

K.L. Canning (Department of Earth Sciences, Cambridge University)

Dr. B. Cogan (formerly British Museum (Natural History))

Dr. M. Fay (Royal Botanic Gardens, Kew)

J. Grimshaw (Department of Zoology, Oxford University)

P. Matyot (Seychelles Broadcasting Corporation)

Dr. N.V.C. Polunin (Department of Marine Biology, Newcastle University)

Prof. P. Racey (Department of Zoology, Aberdeen University)

Dr. M.I. Saaristo (University Museum, Turku, Finland)

Dr. E. Stephens (Department of Geology, University of St. Andrews)

PLANT GENETICS PROJECT

The NPTS is collaborating with the Royal botanic Gardens, Kew in a project of research into the genetics of some of the rarer Seychelles endemic plants. This has developed out of Kew's existing work on the taxonomy and conservation genetics of *Medusagyne oppositifolia* Baker and *Impatiens gordonii* Horne ex Baker. Research on these species is continuing and is aimed at determining the best conservation strategies for preservation of the genetic diversity of such threatened species. Further species will be added to the research programme in future years. Preservation of genetic diversity is a vitally important aspect of conservation and the Seychelles Plant Genetics Project will complement the plant conservation projects currently being undertaken by the Seychelles government's Department of Environment.

ROCHE CAIMAN BIRD SANCTUARY - 1995

1). Mud sampling

During January 1995 hemipteran bugs were observed under flakes of mud, these were active during rain and were calculated to number 2,000m⁻². Diptera were also observed around the margins of water during rain, numbering 4,000m⁻². These animals appear to form the main food source for a number of wading birds, especially curlew sandpipers (*Calidris ferruginea* (Pontoppidan, 1763)).

2). Vegetation surveys

Plants recorded:

Species recorded or identified for the first time in 1994-5 are listed below:

Family	Species	Colonised	
		<1994	1995
Ochnaceae	<i>Ochna kirkii</i>	.	+
Rhamnaceae	<i>Colubrina asiatica</i>	+	.
Caesalpinaceae	<i>Cassia nodosa</i>	.	+

Due to heavy rainfall and blockage of the drainage channel standing water was present in the sanctuary throughout the year. This resulted in *Typha javanica* Schnitzl. ex Zoll. spreading across all open areas. Continuous control of *Typha* is now necessary; hand-clearing was attempted in 1995 but proved unsatisfactory.

3). Invertebrates

3a). Mollusca

On 22/7/94 the mangrove periwinkle *Littorina* cf. *scabra*, was recorded on mangrove stems.

4). Vertebrates

4a). Fish

Large numbers of fish were present in the bird sanctuary throughout the year. Rain water was present in all areas, the sea channel remained blocked so no sea-water entered the sanctuary. This means that the fish were present in largely fresh-water, unfortunately the species concerned were not identified.

4b). Reptiles

A transect along the south fence in January 1995 recorded 2 *Mabuya sechellensis* skinks.

4b). Mammals

Dogs were present throughout the year due to damage to the fence.

ROCHE CAIMAN BIRD SANCTUARY - 1995

4c). Birds

Bird records are summarised below:

Species	J	F	M	A	M	J	J	A	S	O	N	D
Pacific golden plover	4	4	-	0	0	1	0	0	0	4	0	2
Grey plover	6	14	-	0	0	6	21	8	0	25	9	0
Ringed plover	0	0	-	0	0	0	0	0	0	0	0	0
Lesser sandplover	0	6	-	1	0	0	10	0	0	24	10	0
Greater sandplover	0	0	-	0	0	0	0	0	0	1	0	0
Bar-tailed godwit	0	0	-	0	0	2	2	0	0	6	2	0
Whimbrel	15	14	-	14	20	28	18	32	17	81	17	11
Eurasian curlew	0	0	-	0	0	0	0	0	0	1	0	0
Marsh sandpiper	0	0	-	0	0	0	0	0	0	0	0	0
Greenshank	5	6	-	6	12	12	8	1	2	9	2	1
Wood sandpiper	0	1	-	1	0	0	0	0	0	0	0	1
Terek sandpiper	0	0	-	0	0	0	1	0	0	3	0	0
Common sandpiper	2	3	-	0	0	0	0	0	1	2	0	2
Ruddy turnstone	3	21	-	0	0	0	11	21	1	48	39	6
Little stint	0	1	-	0	0	0	1	0	0	0	0	0
Curlew sandpiper	3	38	-	0	0	27	39	15	6	135	17	3
Grey heron	1	1	-	0	1	9	3	1	2	4	1	2
Purple heron	0	0	-	0	0	0	0	0	0	1	0	0
Green-backed heron	3	2	-	2	1	4	1	1	3	5	1	3
Cattle egret	0	1	-	0	0	0	0	0	3	6	1	0
Little egret	0	0	-	0	0	0	0	0	0	0	0	1
Chinese bittern	0	0	-	0	0	0	0	0	0	1	1	1
Black-crowned night heron	0	0	-	0	0	0	0	0	0	0	3	2
Garganey	4	0	-	0	0	0	0	0	0	2	0	1
Northern shoveller	0	0	-	0	0	0	0	0	0	0	1	1
Moorhen	1	5	-	0	1	2	5	1	2	2	1	2

Note: No counts were made in March

Breeding of moorhens in the bird sanctuary was confirmed when two sets of chicks (numbering 1 and 2) were seen in February.

NPTS PROJECTS

Seychelles Giant Tortoise Identification Project

Following the rediscovery of a species of Seychelles giant tortoise (*Dipsochelys 'resurrecta'*) the Seychelles Giant Tortoise Identification Project was organised to determine the species composition of the Seychelles herds. This project uses genetic techniques to identify the species present from DNA extracted from blood samples. Samples were collected from 60 tortoises on Mahé, Cerf, Praslin, La Digue, Cousin, Cousine and Curieuse in January/February 1996. The project also reported on the status and condition of the captive population, breeding rates and the export trade.

450 captive tortoises were estimated to be present on Mahé, Praslin and La Digue, with a further 300 free-range on Cerf, Moyenne, Curieuse, Cousin, Cousine, Fregate, Denis and Bird. The adult sex ratio is male biased (1.4:1 captive 2.6:1 free-range). The juvenile sex ratio is female biased (1:15.0). The breeding population is extremely small, the main hatchling production being dominated by just two regular breeders. Hatchling numbers are also low (averaging a total of 21.6 in 1991-5).

The annual adult mortality rate was estimated at 1% (25% of these being killed deliberately for consumption). Official exports in recent years have run at approximately 50 tortoises per year, rising to 140 in 1995, with an additional significant illegal trade. From calculations of breeding rate and mortality using conservative estimates it is apparent that the current breeding rate is unlikely to balance adult mortality. For population stability annual export of tortoises from Seychelles has to be below 8 adults or 10 juveniles. Current export rates result in an annual decrease in the Seychelles population of 6%. This is masked by poaching from Curieuse, Aldabra and Fregate. There is evidence of tortoises being poached from these populations and incorporated into herds in Seychelles, many of these are probably exported as 'captive bred' tortoises. The majority (90%) of adults are long term captives (origin unknown), 1% from Fregate, 1% from Curieuse, 6% from Aldabra and 2% from 'outer islands'.

Measures were recommended for improving the breeding rate, controlling trade and reducing poaching and theft. At the time of going to press the results of the genetic analysis were not known. In June this year the Division of Environment announced that the export trade would be halted pending the results of a full census.

Acknowledgements

We are grateful to the project's sponsors: Air Seychelles, British Chelonia Group, Linnaeus Fund (Chelonian Research Foundation), Greenwich Workshop, International Market Supply, SeyBrew and P. Treherne. For assistance in the field we are grateful to R. & G. Gerlach, V. Laboudallon, J. Mortimer, J. Neville, P. Hitchins, W. Gardner, S. Remie and to the owners of all the tortoises examined.

NPTS PROJECTS

Conservation of Fregate Island Invertebrates

In mid-1995 brown rats, *Rattus norvegicus* (Berkenhout, 1769), colonised Fregate island for the first time. This is seen as a cause of great concern for the Magpie Robin Recovery Plan and BirdLife International are currently trying to eradicate the rat population. The invasion of Fregate by rats may also threaten the survival of several invertebrate species. For several years the Invertebrate Conservation Centre of the Zoological Society of London has been interested in establishing captive populations of the Fregate island giant tenebrionid beetle (*Polposipus herculeanus* Solier, 1848) and the Seychelles giant millipede (*Sechelleptus seychellarum* (Desjardins, 1834)). The potential threat posed by the rats made the establishment of captive breeding groups an urgent conservation measure. Accordingly the Nature Protection Trust of Seychelles arranged the collection and transport of the giant tenebrionid beetles, giant millipedes and Fregate's endemic snail species (*Pachnodus fregatensis* Van Mol & Coppois, 1980) to the ZSL's Invertebrate Conservation Centre.

In February 1996 Rob Lucking and Vicky Ayrton, currently implementing the Magpie Robin Recovery Plan on Fregate for BirdLife International, collected some 20 adults of each species and despatched them to Mahé, these were then hand carried to the Invertebrate Conservation Centre in London. There they are reported to have settled into their vivaria without losses or apparent difficulty. By May both the snails and the beetles were breeding prolifically. No breeding has been reported in the millipedes to date but they are healthy and have undergone several moults, indicating that they are growing in a satisfactory manner.

These captive breeding groups will providing us with important data on the ecology of the three species and will act as an insurance against their extinction in the wild. Proposals for monitoring the wild populations have been prepared so as to be able to evaluate the effect of the rats on Fregate and a monitoring project is planned for mid-1996. At present the impact of the rats on the native fauna is not known. The establishment of the captive breeding groups should ensure the survival of the Fregate invertebrates believed to be most at risk from rat predation.

Both the giant tenebrionid beetle and the Fregate island snail are currently restricted to Fregate. It is possible that the beetle also occurred on Round Island, Mauritius in the last century; research is continuing into this old record and the possibility and the species used to occur on other Seychelles islands. The giant millipede is a Seychelles endemic found on several islands, populations have been reduced on the larger islands and the main populations are now restricted to Silhouette, Fregate and a number of small sea-bird islands, some of which appear to show local differences, possibly of a sub-specific nature.

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Geology of Silhouette island

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The aptly-named island of Silhouette is the eroded remnant of a large volcanic edifice, which probably once towered well above its present level. The volcano, and its sub-volcanic magma chamber which now forms the bulk of the island, was constructed about 63 million years ago (63 Ma) while Seychelles was parting from India (which had been its immediate neighbour for nearly 700 million years) during the later stages of the break up of the old Gondwana supercontinent. This event occurred at the so-called "K/T boundary" when the Mesozoic gave way to the Tertiary geological period and global changes caused the dinosaurs to become extinct. It was also marked by massive outpouring of lavas on the Indian side, forming the "Deccan Traps" which represent one of the largest volcanic (flood basalt) provinces in the world. Boreholes drilled by Amoco in the early 1980s off the western shelf of Seychelles and by Enterprise in 1995 have shown that up to 800 metres of volcanics are also present on the western shelf and at least 900 metres are present on Constant Bank. How these relate to almost contemporaneous magmatic events which gave rise to Silhouette is the subject of current research.

This contribution is intended to present a general overview of the rocks on Silhouette, which include the only terrestrial volcanic rocks within a thousand miles. North Island is of broadly similar age and there are indications that there are more igneous complexes of this age around the margins of the Seychelles Plateau (eg. possibly Fortune Bank).

Geological Setting

Our knowledge of the geology of Seychelles is based on exposed rock on the 0.015% area of the Seychelles Plateau represented by the islands. Recent studies have demonstrated that the granite islands of Mahé and Praslin formed at about 755 million years ago (Jemielita *et al.* in prep.), with some of the pink granites of Mahé may be a little younger (about 700 Ma). These granites were part of the old basement that underlies much of East Africa, Madagascar, and some of western India, and represents the old Gondwana supercontinent at the interior of which was located Seychelles.

Gondwana was a relatively stable continent until the Mesozoic when, at about 150 million years ago, it started to break up in response to a major

reorganisation of the Earth plates. Firstly, a major rift separated Africa from Madagascar + Seychelles + India + Antarctica + Australia. Then, at about 90 Ma, Madagascar parted from India + Seychelles. The isolation of Seychelles was completed at around 65 Ma when India and Seychelles rifted apart, with a major ocean basin forming between them and the Carlsberg Ridge along the median line. This 65 Ma event was accompanied by the outpouring of a very thick sequence of basaltic lavas, well preserved on India as the Deccan Traps, and the origin of Silhouette is linked to these events.

Igneous rocks

Silhouette is an alkaline ring complex, which means that the composition of the magmas which crystallised to form the syenites and related rocks were richer in sodium than more common igneous rocks (although syenites are by no means unusual rocks), and that the rocks formed by magmas being emplaced concentrically (see map in Fig. 1. and cross section in Fig.3.). The geological map (Fig.2.) shows that the bulk of the island is made of syenite with a core of microgranite in the region of Grande Barbe. Only a thin sliver of volcanic rocks is preserved, although undoubtedly there was considerably more of the volcanic pile before its removal by erosion.

The syenites of Silhouette are generally greenish or buff coloured, occasionally with pegmatitic segregations. Petrographically they are dominated by a perthitic alkali feldspar. The dark minerals are mainly a slightly sodic hedenbergite pyroxene, and the alkaline amphibole arfvedsonite. Under the microscope fayalitic olivine is occasionally seen. The principal accessory mineral is aenigmatite.

The microgranite forms the core of the island and is bounded from the syenites by a steep ring fault which has a marked topographic expression in the precipitous cliffs south of Mont Dauban (Fig. 1. and section in Fig.3.). Such ring faults are common features of alkaline ring complexes on this scale. The microgranite is white coloured, and tends to occupy the lower ground inland of Grande Barbe. Mineralogically it comprises of feldspars and quartz with the blue amphibole riebeckite.

A special feature of Silhouette is the presence of volcanic rocks. Between Pointe Ramasse Tout and Pointe Zeng Zeng (Figs. 1. and 2.) is a narrow sliver of volcanic rocks which comprises a series of thin sheets of light-coloured porphyritic rhyolite and trachyte separating black trachytic ash flows and breccias. The sheets are nearly vertical or steeply westwards-dipping towards the syenite complex. The contact between the syenite and the volcanics appears to be intrusive, implying that the syenite was intruded into a cover of volcanic rocks, suggesting that the whole complex formed at, and just beneath, the surface. The total thickness of these volcanics (Fig. 2.) is about 100 metres, but as the top of the section is not seen the original thickness was almost certainly considerably greater.

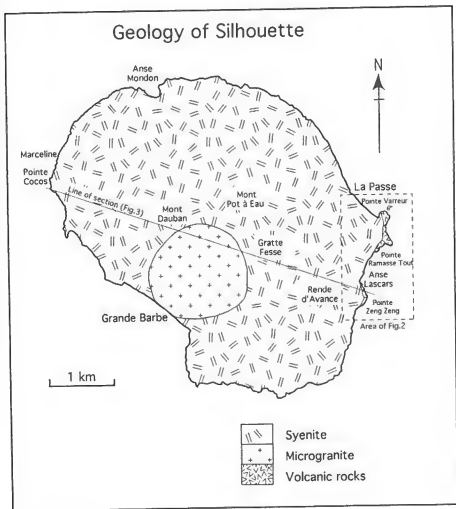


Fig. 1. Map of the major geological units of Silhouette island showing the ring structure of the syenite and microgranite. Inset shows the location of the detailed map of the volcanic section (Fig.2.) and the section line (Fig.3.) is also indicated.

In the field it is possible to see the fragmental nature of the breccias with inclusions of many angular fragments, typically with light coloured rims. Under the microscope many samples have an ignimbritic texture of glass with fiamme structure and matrix felsic minerals enclosing lithic and crystal fragments (Plate 1). The lithic (or rock) fragments include pyroxene- and labradorite-bearing volcanics indicating the presence of basalt flows which are not exposed, but are presumably located beneath these volcanics. The matrix has a streaky form which is known as fiamme structure (Plate 1.) and is typical of ignimbrite (glowing avalanche) eruptions. The fiamme are glass fragments which have been flattened and welded due to the intense heat of the material as it accumulated around the volcanic vent. Glass itself forms when the molten lava cools very rapidly on eruption into the atmosphere. Ignimbrites form during the explosive eruption of a combination of solid material, lava and gas in a dense cloud.

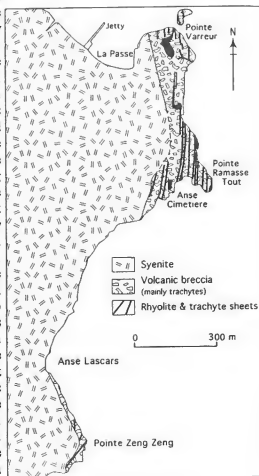


Fig. 2. Map of the coastal volcanic outcrops in the vicinity of La Passe.

Silhouette formed in a manner quite similar to the famous explosive eruption of Mount St Helens in the western USA in 1980. Ignimbrite eruptions are amongst the most rapid and unpredictable, making them the most dangerous of all volcanic eruptions; 63 million years ago Silhouette was not the quiet paradise of today! The evidence suggests that the eruption occurred on land rather than in the sea. The very limited outcrops make it difficult to determine the original form of the Silhouette volcanic complex. The most likely scenario is that an eruptive centre

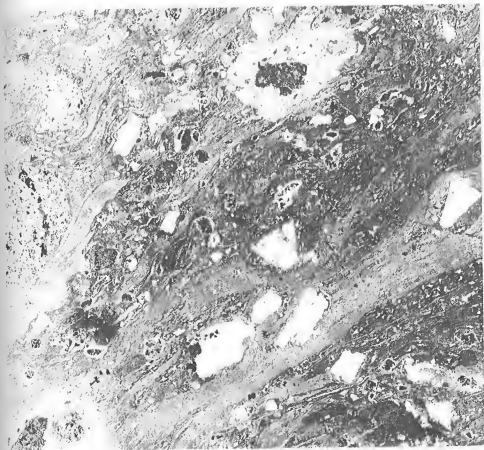


Plate 1. Thin section through a trachytic breccia, Pointe Ramasse Tout, Silhouette. The white crystals are feldspars (sanidine) and the other light and dark coloured rounded patches are lithic (rock) fragments. The streaky matrix is due to the welding of glass fragments and some show flame-like form (fiamme) typical of ignimbritic eruptions. Width of field of view is 12 mm and the picture was taken in cross polarised light.

(and probably a crater) existed south-east of La Passe, but this has now almost entirely been eroded away and submerged. The volcano would have erupted many times, with alternations between explosive eruptions of ash and quieter eruptions of lava flows. A magma chamber also probably existed beneath the Grande Barbe microgranite which finally collapsed into the chamber along the ring fault.

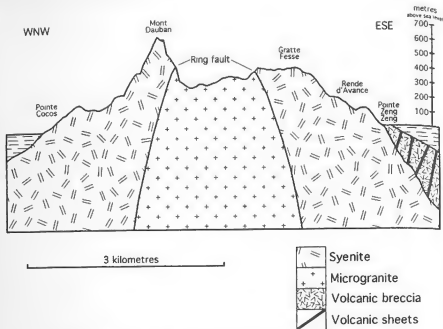


Fig. 3. A topographic and geological cross section through Silhouette along the line indicated in Fig. 1. The ring fault that surrounds the microgranite centred on Grande Barbe forms a marked topographical feature but its subsurface orientation is not well constrained. It is postulated that the small outcrop of volcanics south of La Passe projects offshore, and the volcanic sheets within the breccia appear to dip steeply towards the plutonic centre.

Age and geochemistry

The fact that Silhouette was much younger than the granite basement of Seychelles was first recognised by Baker in 1963 and then demonstrated by Baker & Miller (1963). They obtained ages of 34 to 62 Ma using the K-Ar (potassium-argon) dating technique on an altered pyroxene from a syenite at Roche Marceline (Fig. 1.). Samples of fresher material were analysed again by the K-Ar method (Dickin *et al.* 1986) and five samples representing all rock types in the complex yielded an average age of 63.8 Ma. An independent method (the whole rock Rb-Sr isochron technique) was also applied by Dickin *et al.* (1986) which gave an age of 63.2 ± 1.0 Ma. The very good agreement between these methods gives us confidence that Silhouette formed about 63 million years ago and that the ages of Baker and Miller are too young. Nearby North Island has been shown by the Rb-Sr method to have been emplaced at 60 ± 4 Ma (Yanagi *et al.* 1983), within error of the age of Silhouette.

The volcanics can be related to the syenites of Silhouette through their chemical compositions. The volcanic breccias are compositionally trachytes, and chemical analyses of Silhouette trachytes and syenites are virtually indistinguishable. The sheets of porphyritic rhyolite are more siliceous and correlate well with the composition of the Grande Barbe granite. The isotopic fingerprints of the igneous rocks of Silhouette, as described in the paper by Dickin *et al.* (1986), suggest that the magmas have a primitive mantle-like source and have undergone little contamination by old continental crust.

Correlations within and beyond Seychelles

North Island, only some seven kilometres to the north of Silhouette and lying on the same bathymetric level, is similar to Silhouette in that most of the island is made up of an almost identical syenite. There are, however, differences in that there are no volcanic rocks evident on North Island but its range of compositions is much wider, including alkaline gabbros. As discussed above, their ages are also similar.

The discovery of trachytic tuffaceous material of approximately the same age in the Seagull Shoals-1 and the Owen Bank-1 wells drilled by Amoco (Khanna & Pillay 1986) suggests that there was similar volcanic activity elsewhere. Other igneous centres dating from this time have been postulated from the offshore geophysical record. The largest is Fortune Bank which has a concentric structure in its magnetic and gravity responses, but is considerably larger than Silhouette. Most of these centres that have been recognised are located towards the periphery of the Seychelles Plateau. A regional review of the available age data has been presented by Plummer (1995). Since that review, the drilling on Constant Bank has revealed a great thickness of basic volcanic rocks (>900 metres) and the indications are that these are of generally similar age, but they are probably not related to a central alkaline centre like Silhouette.

In India, the Deccan province of basalts covers more than 500,000 km² of western India, centred on Bombay. These were erupted around 65 Ma, and it is interesting that Seychelles was connected to India in the very region where these eruptions occurred, and that the rift of Seychelles from this part of India occurred at this time. We have speculated (Devey & Stephens 1992) that these Deccan basalts may have also covered at least some of Seychelles at that time and have since been eroded. The evidence is based on a remarkable correlation in the geochemistry of some dykes found on Praslin (including the dyke forming the spectacular waterfall at Cascade) with certain of the early Deccan lavas (Devey & Stephens 1991).

Summary

Silhouette is an alkaline plutonic-volcanic ring complex in which almost all of the volcanic cover has been removed. The volcanism was generally explosive in the form of ash flow eruptions. These events occurred approximately 63 million

years ago, during or soon after one of the world's greatest volcanic eruption events, the Deccan Traps of India. There is a growing body of evidence to suggest that considerable volcanic activity occurred on the Seychelles Plateau at this time including some of the Deccan Traps. Silhouette is very important to geologists as a tiny fragment of this volcanism is preserved and is accessible for study.

Acknowledgements

My work on Silhouette began in 1976 and was facilitated by officials of the Government of Seychelles and the hospitality of Louis d'Offay. I returned in 1990 and again in 1992 and I was grateful for the practical assistance of the IDC on both occasions. At various times in the field I have enjoyed the company of Eddie Belle, Patrick Joseph and Phil Plummer of the Seychelles National Oil Company. My researches on Silhouette have been supported financially by the Royal Society (UK) and the UK Natural Environment Research Council (Grant number GR9/30), and the Carnegie Trust for the Universities of Scotland.

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The effects of habitat domination by invasive Melastomataceae

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Keywords: Seychelles, Mahé, Praslin, Silhouette, *Clidemia hirta*, *Memecylon caeruleum*

Abstract: The structure of habitats dominated by *Clidemia hirta* and *Memecylon caeruleum* in Seychelles are described and their development between 1990 and 1994 reported. *Clidemia hirta* dominated areas have changed dramatically from low closed canopy to a higher, more open structure, correspondingly there has been an increase in plant diversity in the area. The *Memecylon caeruleum* dominated area remains stable, but an area cleared of this plant is changing slowly, with a notable decrease in *M. caeruleum* seedling abundance. This indicates that *M. caeruleum* dominates habitats through slow growth in deep shade, exposure reduces its growth rate. Animal life in *M. caeruleum* litter is very sparse and of low diversity, *C. hirta* litter supports a similar fauna to that of equivalent natural habitats. An association between coccoid bugs and ants is reported, with evidence of selective fruit abortion.

Introduction

The presence of habitats dominated by introduced Melastomataceae species in Seychelles was first reported in 1990 (Oxford University Silhouette Expedition 1990) when *Clidemia hirta* (L.) D.Don was found in almost pure stands on Silhouette. An area dominated by *Memecylon caeruleum* Jack (= *M. floribundum* Bl.) was located on Mahé in 1992 (Gerlach 1993). In 1992 both areas had obviously low plant diversity and appeared to have depauperate faunas (Gerlach 1993). Since then both sites have been monitored on a semi-annual basis, changes in structure have been detected during this period and are described below. In both habitats quantitative measures of plant and animal diversity and abundance have been carried out for comparison with natural habitats.

Memecylon caeruleum dominates an area of 3km² at Beau Vallon, Mahé. Its presence on Mahé has been reported since 1931 (Robertson 1989) and it occurs at low density throughout the northern third of the island (Fig. 1.) (Gerlach 1993). In July 1994 its presence on Praslin was detected for the first time where it occurred as isolated mature plants under the shade of *Cinnamomum verum* J.Presl. trees (Fig. 1.), many of these were flowering but few fruiting. The area at Beau Vallon is a low mountain ridge extending from sea level to 386m, *M. caeruleum* dominates this ridge up to approximately 100m where it forms a complete, dense canopy. A small number of isolated trees of *Cocos nucifera* L. and *Casuarina equisetifolia* L. emerge from this canopy. No seedlings other than *M. caeruleum* occur in this area, these are present at a density of 105m⁻².

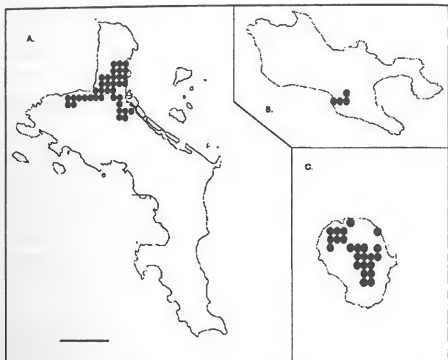


Fig. 1. The distribution of introduced Melastomataceae. Scale bar = 5km.
 A. Mahé (*Memecylon caeruleum*). B. Praslin (*M. caeruleum*).
 C. Silhouette (*Clidemia hirta*)

Measurements of numbers of seedlings and mature plants, canopy cover and canopy height were made in 1992 and repeated in 1994. In addition ten 5x5m areas were cleared in June 1993. In these patches all plants were felled to ground level, the soil and seedlings were left largely undisturbed. The number of mature plants and seedlings of all plant species were recorded one month after clearance and these counts repeated in December 1993 and June 1994. The number of seeds present in 1m² was recorded. Repeat observations were made in January 1996.

Animals in the area were recorded by casual observation and quantitative counts on 100 plants in each observation period. 1m² of leaf litter was collected in July 1994 and the animals present in it extracted by means of a Tullgren funnel, providing an estimate of animal abundance for comparison with data from other habitats (Gerlach 1995).

In Seychelles *Clidemia hirta* is primarily restricted to Silhouette, a single seedling was found at Le Niol, Mahé in 1993 and removed, none have been

reported subsequently. On Silhouette it dominates two areas: Mon Plaisir (2000m²) and the central part of Mare aux Cochons (50m²). Scattered plants are present throughout the northern half of the island, where in 1990 it was restricted to areas above 400m. In 1991 small isolated plants were found down to 200m above sea level. These had matured by 1993 but remained small, a single mature plant was found in that year at sea level. No change in distribution was detected in 1994. The current distribution is shown in Fig. 1.

The Mon Plaisir site has been the main focus of monitoring studies due to its accessibility. This population is at an altitude of 570-590m. At this site records have been made of numbers of mature *C. hirta* plants, seedlings and other plants, canopy cover and height in 10 1m² quadrats in August 1990, July 1991, July 1993 and December 1993. The number of fruits set per plant and the number of seeds per fruit were counted and compared to similar records from plants at different altitudes. Leaf litter was collected from 10m² and animals extracted using a Winkler apparatus in December 1993. The residue from this was subsequently kept damp in warm conditions to germinate any seeds present within it.

Memecylon caeruleum

Structure

The mean values of numbers of stems and seedlings, and canopy cover and height are shown in Table 1. Comparisons of these with a Model III (repeat-measures) analysis of variance (Anovar) does not detect any statistically significant difference. In the cleared areas there was no regrowth of the cut stems, data from these sites are shown in Table 2., using mean values. T-tests of the means of the data for each of the two years sampled show that there has been a significant increase in the abundance of *Asystasia* sp. No significant differences are detectable in *Ipomoea venosa* (Desr.) Roem. & Schultes or *Passiflora suberosa* L. as these occur in very low numbers. *Litsea glutinosa* (Lour.) C.B. Robinson numbers have increased but are still not significantly different. Most importantly the abundance of *M. caeruleum* has not increased, there is a non-significant decrease in numbers of mature plants and a significant decline in seedling numbers. This indicates that colonisation of exposed areas by *M. caeruleum* is a slow process and that seedling germination or survival is enhanced by shading. In 1994 there were 650 *M. caeruleum* seeds per square metre on the ground and only 3.4 seedlings per square metre, indicating that a major component of the seedling decline is due to very low rates of germination in exposed areas (possibly as a result of overheating or insufficient soil moisture). By January 1996 the cut area had reached the 3m height of the surrounding vegetation.

Table 1. Means of *M. caeruleum* factors recorded at Beau Vallon

Date	stems	seedlings	canopy %	height (m)
1992	0.6	0.5	100	3.5
1993	0.8	0.4	99	3.4
1994	0.4	0.6	100	3.8

Table 2. Mean numbers for the cleared *M. caeruleum* area, significant differences are marked with asterisks (* $P < 0.05$, ** $P < 0.01$)

Date	<i>Asystasia</i> sp.	<i>Ipomoea</i> <i>venosa</i>	<i>Passiflora</i> <i>suberosa</i>	<i>Listea</i> <i>glutinosa</i>	<i>Memecylon</i>	
					seedlings	plants
1993	0.30	0.10	1.00	0.30	13.60	0.80
1994	2.30	0.00	0.00	1.30	3.40	0.40
t	3.86**	1.00	1.00	1.67	3.13*	1.34

Fauna

The only animals observed on the *M. caeruleum* plants were ants (*Technomyrmex albipes* Smith), coccoid bugs (*Icerya seychellarum* (Westwood, 1855)) and their introduced coccinellid beetle predator *Chilocorus nigrinus* (Fabricius). There were significant correlations between the presence of ants, coccoids, the presence of ant nests in the apical cap of the fruit and fruit colour (see Table 3.). The presence of ant nests in fruit caps and *I. seychellarum* presence are correlated with ant presence, which is correlated with fruit colour. Ants are present on 63% of purple (mature) fruit and 80% of pink (immature) fruit, indicating that immature fruits are predominantly inhabited by ants and either that purple fruit are less suitable or that vulnerable fruit do not develop to maturity.

When ants are present 97% of pink fruits and 88% of purple fruit have *I. seychellarum* infestations. All ant nests are built in purple fruit, all associated with *I. seychellarum* (this is not significant due to the low total number - 5), suggesting that the association of *I. seychellarum* with ants is a significant fruit mortality factor, resulting in the abortion of immature *I. seychellarum*-ridden fruit. This would result in a lower frequency of infestation of ripe fruit. The association of nest development and fruit maturity is probably due to the time required for nest development exceeding the immaturity period of fruit.

Only four individuals of the predatory beetle *Chilocorus nigrinus* were observed. This species was deliberately introduced to prey on coccoids, however, as *I. seychellarum* is rarely eaten and predator abundance is known to decline with ant presence (Hill & Blackmore 1980) it is not a significant component of ant-coccid associations.

Table 3. Pearson's rank correlation coefficients for animals on *M. caeruleum* fruits
(* $P < 0.05$, ** $P < 0.01$)

n=57	Ants	Nests	<i>Icerya</i>	Colour
Ants	-			
Nests	0.253*	-		
<i>Icerya</i>	0.287*	0.198	-	
Colour	0.372**	0.019	0.123	-

Litter fauna - No data from natural lowland forests are available for comparison with *M. caeruleum* litter. The samples collected reveal a low diversity fauna containing five species of mite (75.0m^{-2}), one cosmopolitan isopod (*Aphiloscia annulicornis* (Budde-Lund, 1885)) (75.0m^{-2}), two dipteran species (5.0m^{-2}), one unidentified scolytid beetle (5.0m^{-2}) and ants (*Technomyrmex albipes* and *Anoplolepis longipes* (Jerdon, 1851)) (20.0m^{-2}). Observations of natural lowland habitats suggest that this fauna is unusually species poor, particularly in its absence of molluscs.

Clidemia hirta

Structure

The mean values of the density of plants, stems and canopy height are shown in Table 4. Model III (repeat-measures) analysis of variance of these data show that there are significant decreases in the canopy cover ($F_{0.05(23,27)}=6.39$, $P < 0.005$), increases in canopy height ($F_{0.05(23,27)}=15.03$, $P < 0.001$) and a decline in the number of stems 1m above ground ($F_{0.05(23,27)}=11.17$, $P < 0.001$). There is a marked, but statistically insignificant, decline in *C. hirta* seedling numbers after 1993. Temporal changes in canopy cover, height and stem number can be described by statistically significant regressions. However, these have very low R^2 values (< 0.23) due to the high variance of the data and are thus of little predictive value. These comparisons show that between 1990 and 1994 the *C. hirta* plants increased their height by 76%, resulting in an opening out of the vegetation structure and canopy thinning. Accompanying this the number of seedlings of other plants increased (especially ferns and *Roscheria melanochaetes* (Wendl.) Wendl. ex Balf.), however the numbers recorded are too low for statistical significance to be tested.

Fruiting and seed germination

Ripe fruit and open flowers have been observed in all seasons. The numbers of flowers, green (unripe) fruit, blue (ripe) fruits and seeds at different sites in July 1993 are shown in Table 5. There are significant differences between each site in the number of flowers (Anovar $F_{0.05(22,18)} > 6.20$, $P < 0.02$), green fruit ($F_{0.05(22,18)} > 4.82$, $P < 0.05$) and blue fruit ($F_{0.05(22,18)} > 5.89$, $P < 0.05$) demonstrating that there is a relationship between reproductive output and altitude. The number of seeds per fruit does not demonstrate any clear pattern but is greatly reduced at

Table 4. Means of *C. hirta* data from Mon Plaisir

Date	Canopy (%)	Height (m)	Seedlings	Stems
7.90	89.9	2.1	1.7	3.9
7.91	76.4	2.4	2.2	3.9
7.93	68.0	3.0	2.0	1.6
1.94	56.0	3.7	0.6	1.1

Table 5. Numbers of flowers, fruit and seeds per *C. hirta* plant

Site	Altitude (m)	Flowers	Green fruit	Blue fruit	Seeds per fruit
Mon Plaisir (n=10)	500	3.6	37.6	20.2	527 (n=10)
Jardin Marron (n=10)	300	5.1	18.2	5.7	458 (n=10)
Baie Cipailles (n=1)	0	4	3	1	35 (n=1)

sea level. This altitude effect may result from the higher humidity of upland sites and the strong effects of coastal salt-laden winds.

Seedlings were germinated from 10m² of leaf litter collected in July 1993 (litter kept damp at 18°C for one year), these numbered 881 *C. hirta*, 8 *Dillenia ferruginea* (Baillon) Gilg, one *Northea hornei* (Hartog) Pierre and 1 *Mapania seychellarum* Simpson. This predominance of *C. hirta* is not surprising given the abundance of fruit but is in marked contrast to the numbers of seedlings in the study site (2.0m⁻²). The low numbers of seedling recorded in the field is in accordance with data on other Melastomataceae demonstrating that germination is more successful beneath gaps in the canopy (21% emergence) than in the understory (4% emergence) and that seedling survival is low (0.1-0.4% surviving to one year) (Ellison *et al.* 1993). The Mon Plaisir data give seedling emergence as 2.0% which is comparable to the understory value given by Ellison *et al.* (1993). The survival rate at Mon Plaisir also appears to be very low as indicated by the large number of seedlings germinated under artificial conditions being eaten by litter inhabiting beetles prior to development of the characteristic epidermal hairs.

Seedlings were also observed growing in rat (*Rattus rattus* (Linnaeus, 1753)) faeces suggesting that rats may act as significant dispersal agents.

Animal life

Leaf litter inhabiting animals were sampled from 10m² at Mon Plaisir using a Winkler apparatus. Data from a comparative site on Mahé (Congo Rouge) were used in comparison in Table 6. The numbers of each animal taxon were compared using a t-test for samples with unequal variance, only significant results are shown. These data show that the faunas are similar. There are some significant differences, specifically more Isopoda, Araneae and Hemiptera at Mon Plaisir and more Diptera at Congo Rouge. Such differences are difficult to explain at present but it appears that most of the fauna is not significantly affected by *C. hirta* dominance.

Table 6. Faunal comparison of Mon Plaisir and Congo Rouge

taxon	Mon Plaisir	Congo Rouge	T-test value	P
Mollusca	0.40	6.75		
Annélida	0.80	1.50		
Amphipoda	0	0.25		
Isopoda	10.60	1.25	3.07	0.01
Araneae	2.70	0	3.95	0.003
Pseudoscorpiones	0.40	0.25		
Opiliones	0.10	1.75		
Schizomida	0	0.25		
Myriapoda	1.80	3.25		
Thysanura	0.30	0.25		
Psocidae	0	0.25		
Dyctioptera	0.60	0.25		
Mallophaga	0	0.25		
Hemiptera	13.20	0.25	3.88	0.004
Orthoptera	0.10	0.25		
Lepidoptera	0.20	0		
Diptera	1.10	3.75	-2.53	0.026
Coleoptera	7.60	8.50		
Hymenoptera	10.20	25.75		
Reptilia	0.10	0		
Amphibia	0.20	0.25		

Discussion

Introduced Melastomataceae species have been reported as causing major conservation problems in many parts of the world, including the western Indian Ocean (Cadet 1989; Gueho 1988). In Seychelles they have only recently been identified as a threat to natural habitats. Study of their fauna and flora demonstrate that both *Memecylon caeruleum* and *Clidemia hirta* dominated areas have low plant diversity but that *C. hirta* areas support a largely natural fauna. The animals inhabiting the *M. caeruleum* area are mainly cosmopolitan taxa, the most abundant being part of the *Technomyrmex albipes* - *Icerya seychellarum* association parasitising the plants. An association between *I. seychellarum* and ants has been described previously (Hill & Blackmore 1980). All *I. seychellarum* populations observed were tended by ants, thus preventing the build up of honeydew and the infection of the plant by capnodiacean sooty mould (Hill & Blackmore 1980). The ability of *M. caeruleum* to withstand this parasitism is shown by the selective abortion of heavily parasitised fruits.

Monitoring of the areas concerned suggests that *M. caeruleum* dominance is stable and that it is achieved through rapid growth of seedlings in dense shade. Exposed areas are unsuitable for *M. caeruleum* seedling growth. Although it has spread slowly to date and is not reported from other localities *M. caeruleum* is becoming an increasingly important component of the vegetation of Mahé. Its

recent colonisation of Praslin is a cause for concern (although a brief search in January 1996 failed to locate the plants noted in 1994).

In contrast the well known threat posed by *C. hirta* appears to be a temporary phenomenon, on Silhouette at least. Growth is rapid both in shade and sunlight. Low humidity and/or high levels of salt-spray appear to depress growth and reduce fruiting levels. It does reach a dominant state in open areas but with time develops an open structure. This allows high levels of light penetration and consequent high rates of seedling survival. There is no evidence of any competitive advantage of *C. hirta* seedlings in natural habitats so, despite the abundance of *C. hirta* seeds in the leaf litter, a high canopy allows a natural process of succession to occur. On Silhouette this process is resulting in reduction in *C. hirta* dominance and a return towards a natural high-altitude flora.

The changes reported here will continue to be studied. The results of the monitoring that has been undertaken to date identify *M. caeruleum* as a significant threat in the degraded habitats of Mahé and Praslin but indicate that *C. hirta* is a temporary problem in natural areas. The best means of managing *C. hirta* may be to adopt a non-interventionist approach where the surrounding habitats are in good health and are robust. Direct control may be required where habitat degradation has reached such a degree that natural processes are inoperative. This must be approached very carefully as *C. hirta* appears to be a pioneer species that would actually benefit from most of the available management options.

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Patterns of hybridization and extinction in a tropical land snail

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Keywords

Pachnodus, Seychelles, Mollusca, Gastropoda, Enidae

Abstract

The extinction of a species of land snail from Seychelles, *Pachnodus velutinus*, is reported. This is the result of swamping by a hybrid taxon *P. niger* × *velutinus* following the movement of a hybrid zone. The hybrid zone movement and the extinction process were followed over the years 1986-1994.

Introduction

Numerous hybrid zones have been reported from a wide range of localities and taxa (Hewitt 1988). These may provide important insights into the processes that lead to full speciation from diverging sympatric genotypes or to convergence (introgression) following the breakdown of barriers between allopatric taxa.

Several patterns of fitness between hybrid and parental genotypes can be distinguished including equal fitness, one homozygote fitter than the others, heterozygote (hybrid) disadvantage, positive frequency dependence for homozygotes and hybrid advantage (Hewitt 1988). When one of the genotypes has an advantage over the others this tends to spread through the hybrid zone (Barton & Hewitt 1985). This is a feature of particular interest in understanding the potential instability of some zones and the speed of speciation or introgression. However, due to the rapid rates of gene flow that tend to occur in such situations there are relatively few reported examples of moving hybrid zones (Gill 1980; Hewitt 1988; Hillis & Simmons 1986; McDonnell, Gartside & Littlejohn 1978; Picozzi 1976; Yang & Sealander 1968). The study presented below describes one such case of a moving zone. This hybrid zone between two land snail species is unusual in that its composition was studied at regular intervals between its discovery in 1986 and the complete extinction of one of the parent taxa in 1994.

A hybrid zone occurs between species of the *Pachnodus* genus of land-snail (Mollusca; Gastropoda; Enidae) on the island of Mahé, Seychelles. These snails are largely arboreal (Gerlach 1991, 1994) and, unlike all other hybridizing snail species studied, have relatively high dispersal rates. Published studies of hybridization patterns in snails usually concern highly sedentary genera such as *Albinaria* (Shilthuizen 1995; Schilthuizen & Lombaerts 1995), *Cerion* (Gould & Woodruff 1986; Woodruff 1981) and *Partula* (Johnson, Clarke & Murray 1990; Johnson, Murray & Clarke 1993) where annual dispersal is in the region of only 3m (Murray & Clarke 1984). In contrast *Pachnodus* species may move some 220m annually (Gerlach 1994a). This relatively high dispersal rate raises the possibility

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of detectable dynamic movement of the hybrid zone as the small-scale environmental clines that restrict the *Albinaria*, *Cerion* and *Partula* hybrid zones can easily be crossed by *Pachnodus*.

The presence of a hybrid zone within the distribution of *Pachnodus* was first identified in 1986; since then it has been investigated on an annual basis. In 1994 it was discovered that one of the parent taxa had become extinct following a shift in the location of the hybrid zone. The pattern of movement of the zone observed between 1986 and 1994 is described below.

Identity of the hybrid taxon

The hybrid form *Pachnodus (Pachnodus) niger* × *velutinus* was described in 1994 (Gerlach 1994b) on the basis of shell and anatomical characters being intermediate between *P. niger* (Dufo, 1840) and *P. velutinus* (Pfeiffer, 1841). In this description the intermediate morphology was considered to be the result of hybridization between *P. niger* and *P. velutinus*, although evidence for the hybrid origin was not presented. The intermediate morphology could have arisen from hybridization, as suggested, or from incomplete separation of speciating taxa. The geographical distribution of characters allows these possibilities to be distinguished. Incomplete speciation would be expected to be characterised by clinal distributions of characters whereas hybridization could produce an apparently random distribution of intermediate characters. Mantle colouration does appear to follow a clinal pattern with pale forms being found in areas surrounding the range of the pale *P. vultinus*, however, there is no similar increase in the intensity of black pigment near the range of *P. niger*. Anatomical characters are constant and represent a combination of *P. niger* and *P. velutinus* states with no intergradation between them. The only variable character is the number of lateral radular teeth which cover the range of 188–192 as opposed to the constant 220 in *P. velutinus* and 181 in *P. niger* (Gerlach 1994b). The number of teeth does not fit any detectable pattern of geographical distribution with the full range being found in all populations. This lack of evidence of clinal patterns supports hybrid origin of the intermediate taxon.

The origin of this taxon was further investigated by obtaining laboratory crosses between individuals of different populations. Pairs of the three taxa were maintained at 20°C and 90% humidity. In all cases wild-collected juvenile snails were used in the crosses to eliminate the possibility of sperm storage producing misleading results. All three taxa bred true. In the intermediate taxon the number of lateral radular teeth remained variable with no significant correlation between parental and offspring radular formulae. Offspring shell colour was indistinguishable from that of the darkest parent. Crosses between the taxa consistently produced the morphology of the intermediate taxon with the characteristic reproductive anatomical structures (Gerlach 1994b), the full range of radular formulae and the dominance of the darker colouration. All of these data

are congruent with a hybrid origin, supporting the classification of the intermediate taxon as the hybrid *Pachnodus niger* × *velutinus*.

Numbers of offspring produced by various crosses carried out in 1988 and 1989 are shown in Table 1. No significant differences in the mean numbers of eggs or the hatching rate were detected. From these crosses and from dissections of wild-collected snails (Gerlach 1994b) it was concluded that in 1987 the fully fertile hybrid *P. niger* × *velutinus* was present in an area surrounding *P. velutinus*. (Fig. 1)

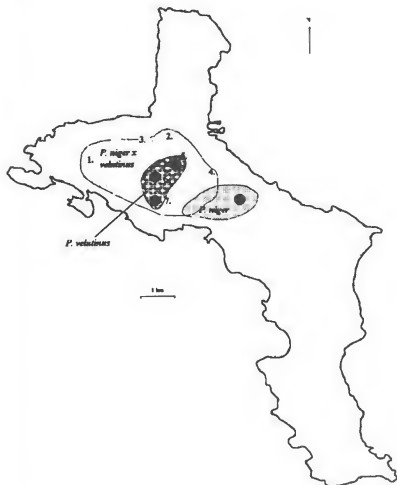


Fig. 1. Ranges of *P. velutinus*, *P. niger* and *P. niger* × *velutinus* in 1972. Scale bar = 1km. Sites mentioned in the text are numbered.

Table 1. Results of crosses between the taxa (means and standard errors)

Cross	Origin	Number of clutches	Number of eggs	% successful hatchings
<i>P. niger</i>	wild	5	26.6±4.2	92.6±4.0
<i>P. velutinus</i>	wild	5	24.2±1.6	90.6±9.5
<i>P. niger</i> / <i>P. velutinus</i>	wild	6	25.0±3.6	91.3±9.7
<i>P. niger</i> × <i>velutinus</i>	wild	15	24.6±7.8	80.0±23.2
<i>P. niger</i> × <i>velutinus</i>	F ₁ captive	8	20.9±4.8	90.8±8.3

Table 2. Differences between the three taxa

	<i>P. velutinus</i>	<i>P. niger</i>	<i>P. niger</i> × <i>velutinus</i>
Shell thickness (mm)	<0.5	1.0-2.5	0.5-1.5
Rectum colour	banded	white	banded
Number of lateral radula teeth	220	181	188-192
Shell colour	beige	black	variable

History of the *Pachnodus* hybrid zone

The first definite specimens of the hybrid taxon *Pachnodus niger*×*velutinus* were collected on 15th July 1986 (Gerlach 1994b).

Three characters are of particular note in the hybrid form: typically the shell is strong, the rectum (visible through the shell) marked with black and white bands and the radula formula is highly variable. In *P. velutinus* the shell is very poorly calcified and in some specimens no significant inorganic layers underly the fragile periostracum whilst *P. niger* shells are always well calcified (Gerlach 1994b; Van Mol & Coppo 1980). The rectum is clearly banded in black and white in *P. velutinus*, but is white in *P. niger*. The radula formulae are different in *P. velutinus* and *P. niger* but do not exhibit any intraspecific variation. These characters are compared in Table 2. There are also significant differences in reproductive anatomy (Gerlach 1994b). These three characters allow preserved material to be identified and can also be applied to some historical descriptions.

The first record of a probable hybrid dates from 1880 (Mobius, Richters & Martens 1880). A dissection of a specimen of '*Bulimus velutinus*' gives the number of lateral teeth on the radula as 190 which would fit within the range for the hybrid, indicating the occurrence of hybridisation in the 1800s. The large collection of *Pachnodus* in the Musée Royale de l'Afrique Centrale, Tervuren, collected in 1972 (Van Mol & Coppo 1980) does not include any hybrids. This suggests that hybrids were uncommon or localised at that date, however no specimens were collected from the area between the main ranges of *P. niger* and *P. velutinus*. The 1972 ranges of the parent taxa are shown in Fig. 1.

Study methods

During 1987 field studies showed that the hybrid was distributed throughout all suitable areas of damp forest in the north of the island. *P. velutinus* could only be found at Congo Rouge whilst *P. niger* remained in the centre of the island without having suffered any apparent range contraction since 1972.

In order to study the process of range expansion of the hybrid a series of sites were visited during July & December/January of each year. These months are normally the driest and wettest months respectively, thus the data collected cover any seasonality that may be present in distribution patterns. A set route was walked at each site and the number of *Pachnodus* found was recorded. These were recorded as four distinct morphs:

- a. *P. velutinus* - light colour, thin shell, banded rectum
- b. *P. niger* × *velutinus* (light) - light colour, thick shell, banded rectum
- c. *P. niger* × *velutinus* (dark) - dark colour, thick shell, banded rectum
- d. *P. niger* - dark colour, thick shell, pale rectum

The number of visits to each site varied, most effort was concentrated on repeat surveys of Congo Rouge where *P. velutinus* persisted.

The sites examined are listed below and marked on Fig. 1.

1. Mare aux Cochons
2. Trois Frères
3. Le Niol
4. Copolia
5. Morne Seychellois (*P. velutinus* present in 1972)
6. Congo Rouge (*P. velutinus* present in 1972)
7. Morne Blanc (*P. velutinus* present in 1972)

Results

Only dark morphs of *P. niger* × *velutinus* (morph c.) were present at sites 1., 2. and 3. The changes in abundance of each form at the other four sites are recorded in Table 3.

Table 3. Numbers of different morphs at the main field sites

Site	Morph	Year								
		1986	1987	1988	1989	1990	1991	1992	1993	1994
4.	b.	-	-	24	0	0	0	0	-	-
	c.	-	-	14	35	20	4	34	-	-
5.	b.	-	-	-	-	-	1	-	-	-
	c.	-	-	-	-	-	12	-	-	-
6.	a.	-	54	35	35	21	11	6	3	0
	b.	-	26	5	10	10	7	12	6	26
	c.	-	8	2	5	6	6	7	5	6
7.	b.	0	13	17	18	13	0	0	0	-
	c.	8	29	24	36	34	6	44	40	-

The presence of *P. velutinus* at Congo Rouge (Site 7) justifies more detailed consideration of this area. The site is shown in Fig. 2, using the habitat classifications of Gerlach (1993). This area can be divided into 5 sections (labelled on Fig. 2). The data for these 5 sections are given in Table 4.

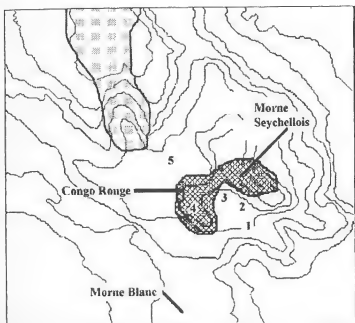


Fig. 2. Habitats and localities at Congo Rouge mentioned in the text.

Table 4. Numbers of different morphs at Congo Rouge

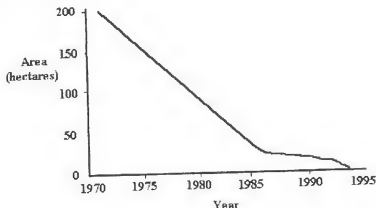
Area	Morph	Year							
		1987	1988	1989	1990	1991	1992	1993	1994
6.1.	a.	1	4	0	0	0	0	0	0
	b.	14	3	7	6	4	3	2	6
	c.	0	0	1	2	2	2	3	3
6.2.	a.	3	15	18	11	2	2	0	0
	b.	0	0	0	0	0	2	2	11
	c.	0	0	0	0	0	0	0	0
6.3.	a.	10	10	11	9	6	3	2	0
	b.	0	0	0	0	0	4	1	3
	c.	0	0	1	1	2	1	1	1
6.4.	a.	5	6	6	1	3	1	1	0
	b.	12	2	3	4	3	3	1	6
	c.	0	0	0	1	0	0	0	0
6.5.	a.	0	0	0	0	0	0	0	0
	b.	0	0	0	0	0	0	0	0
	c.	8	2	3	2	2	4	1	2

Discussion

As can be seen from these data the invasion of the area by *P. niger*×*velutinus* was relatively slow with considerable spatial and temporal overlap of this taxon and *P. velutinus*. The gradual decline of *P. velutinus* is concordant with the pattern that would be expected to result from genetic drift through non-assortative mating. The last individuals of *P. velutinus* were observed in the moist forest habitat of Site 6c. when they were coexisting with *P. niger*×*velutinus*.

The field data presented above demonstrate that since 1972 *P. niger*×*velutinus* has undergone a significant range expansion. By 1987 the hybrid was present in all low and mid-altitude forested areas in the north of the island. Invasion of the high forest appears to have been slower and in 1987 at least some of the hybrids occupying the high forest of Copolia, Morne Blanc, Trois Frères and Morne Seychellois retained the light colouration of the *P. velutinus* parent (morph b.). At this time this parent taxon was restricted to the mist forest area of Congo Rouge where it was present in some 23 hectares (the dampest and most climatically stable area of the island). By 1989 the pale colouration of *P. velutinus* had disappeared from the hybrid population which were now externally indistinguishable from *P. niger* (although they remained distinct in terms of their reproductive morphology). Over the years the range of *P. velutinus* has contracted (the change in the estimated area is shown in Fig. 3.) until by July 1994 no pure *P. velutinus* could be located.

Fig. 3. Range contraction of *P. velutinus* since 1972



This process of range contraction leading to extinction has a primary cause in the expansion of the hybrid. Possible explanations for this rapid extinction process lie in the nature of this particular hybridisation process and that of the hybrid zone. From the data in Table 2, it is clear that the hybrid taxon is fully fertile and suffers no hybrid disadvantage in terms of reproductive success. This would allow it to spread into the parent population in the absence of any selective disadvantage. For the zone to remain stable a degree of selection against the hybrid would be required. This can be calculated as

$$W^2 = (2.08L)^2 / S$$

where W = width, L = mean dispersal rate, S = selection against hybrids (Endler 1977). This assumes no assortative mating and equal selection against all hybrids. For *P. niger* × *P. velutinus* the stable hybrid zone must have been approximately 2 km wide. The mean dispersal rate is 0.22 ± 0.02 km per year (Gerlach unpublished data) giving $S = 0.05$. This low level of selection means that the stability of the zone could easily be disrupted by relatively minor changes in the level of selection caused by environmental fluctuations.

If the hybrid zone between *P. niger* and *P. velutinus* is assumed to have been stable prior to the anatomical studies reported above (including that of Mobius *et al.* 1880) then a process of slow genetic drift could be postulated as occurring over a narrow hybrid zone of approximately 2 km. The rapid range contraction since 1972 (on average some 9 hectares annually, with an initial peak of 18 hectares) requires that there be a significant element of hybrid advantage at

this time. There are three main morphological differences between the hybrids and *P. velutinus* from which to account for such an advantage: reproductive tract anatomy, radula variability and increased shell thickness. Given that there is no obvious reproductive advantage in the hybrid form (Table 2.) the first character is of uncertain value. The radula would have a selective value were it not for the variability in the hybrid form; variation would allow the taxon as a whole to exploit minor differences in food resources but this would be more likely to lead to specialisation into a number of radula morphs than to continuous variation. This leaves the shell which has two obvious functions. Firstly it acts as a protection device; given that *P. velutinus* survived in considerable numbers between 1836-1972 (Dufo 1840; Van Mol & Coppo 1980) the thin shell cannot have been a major disadvantage. The second function would be to reduce water loss by sealing off the upper body surface. This may provide the key to the problem. When humidity levels drop below 70% most *Pachnodus* species enter aestivation (pers. obs.). This is not achieved by the formation of a complete epiphragm but rather by the secretion of a partial seal around the edge of the aperture and the substrate. The substrate must be a reasonably flat surface and accordingly in seasonally dry areas characteristic double hemispheres (formed by the two sides of the divided sole of the *Pachnodus* foot) of thick dry mucus can be found on the fronds of the birds nest fern *Asplenium nidus* L.. This aestivation behaviour was observed in captivity in adults of all taxa, except *P. velutinus*. In *P. velutinus* survival required a humidity constantly in excess of 80%, below this they rapidly desiccated and died.

Considerable changes have occurred in the forests of Mahé. Although forest cover is largely complete at present, this is almost entirely secondary. Within the historic range of *P. velutinus* extensive areas were cleared for tea and timber plantations in the 1960s (Piggott 1968; Sauer 1967). This change in forest distribution and structure would be expected to have had some effect on the local climate of the surrounding forest. It may be that the probable decrease in humidity of the partially cleared mid-altitude forest may have resulted in *P. niger* × *velutinus* having a selective advantage over the thin shelled, desiccation prone *P. velutinus*. With such an advantage the spread of *P. niger* × *velutinus* into the low and mid-altitude range of *P. velutinus* would be expected. In the higher areas where the humidity rarely falls below 95% the selective advantage would be absent but the large source population of *P. niger* × *velutinus* surrounding the *P. velutinus* remnant would lead to genetic swamping through random mating patterns. The reduced rate of range contraction in 1987-93 corresponds to this switch from hybrid advantage to genetic swamping.

The above hypothetical process of selective advantage and random drift would lead to the observed pattern of apparently rapid invasion of low to mid-altitudes and a slowing of the rate of invasion as shown in Fig 3. The hybrid form would have no advantage over the *P. niger* parent which was the original source of

the low desiccation tolerance and thus the hybrid zone would remain stable at its southern edge.

This event is one of the few cases where an extinction process has been followed to its conclusion. It is also one of the few observed cases where the process, hybridisation, has been largely natural although habitat disturbance may have speeded up the event. There have been no previously reported cases of hybrid advantage resulting in the total extinction of one parent species. Reports of moving zones refer either to hybrid disadvantage as in birds (Moore & Buchanan 1985; Yang & Selander 1968) and frogs (McDonnell *et al.* 1978) or to hybridization occurring in connection with other, more important, demographic influences such as major habitat change or competition (Gill 1980; Moore & Koenig 1986; Picozzi 1976; Short 1969). The hybrid zone reported above demonstrates that hybrid superiority is possible and can lead to extinction of at least one of the parental taxa. Furthermore a zone developing as a result of secondary contact may remain stable indefinitely but can be disrupted by environmental changes; once instability develops, the process of expansion of the zone and extinction of parental taxa may be extremely rapid.

Three explanations have been proposed to account for the persistence of hybrid zones following secondary contact. These are the ephemeral zone hypothesis, the dynamic equilibrium model and the geographically bounded hybrid superiority model. The first of these leads either to speciation (if the parental taxa are sufficiently divergent to result in hybrid unfitness) or to fusion (where the hybrid acts as a bridge for introgressive hybridization). The second results in stability despite selection against the hybrids; under this model a broad contact zone develops. In the hybrid superiority model the hybrid has an advantage in a restricted area which leads to a stable, narrow zone. Of these three the last has been favoured as a general explanation as it is the only model to account for the persistence of narrow, stable zones (Heaney & Timm 1985; Moore 1977). The data presented in this study suggest that a narrow hybrid zone formed as a result of the geographically bounded hybrid superiority model can shift into the ephemeral zone form following environmental change. This means that no single explanation need apply to a hybrid zone throughout its history. Changes in the environment can disrupt the underlying processes such that stable zones may become zones of speciation or of introgression.

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Plate 1. *Polposipus herculeanus*, the Fregate island giant tenebrionid beetle



2. *Memecylon caeruleum* invading Mahe & Praslin



Plate 3. Part of the newly discovered *Impatiens gordonii* population on Silhouette
(photo by M. Kirkpatrick)



The extinct snail *Pachnodus velutinus* (left)
and the hybrid form *P. niger* × *velutinus* (right)



Plate 5. The rediscovered Seychelles terrapin *Pelusios seychellensis*



Plate 6. *Pelusios seychellensis* showing the characteristic black plastron



Plate 7. *Calophyllum* wilt disease: Large dying *Calophyllum inophyllum* at Victoria Botanical Gardens. (photo by M. Ivory)



Plate 8. *Calophyllum* wilt disease: Stem section of dead tree at Sans Souci showing brown flecking and black streaks in the outer wood. (photo by M. Ivory)

Wilt of Takamaka (*Calophyllum inophyllum* L.) in Seychelles

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Key words: Seychelles, *Calophyllum*, *Verticillium* Wilt

Abstract: Dieback and mortality of Takamaka on Mahé is a Vascular Wilt Disease apparently new to this host in Seychelles. During a survey in August 1994 disease foci were recorded from 3 localities on the island on Mahé. These were all small in extent, although the pathogen seems to be very aggressive to this host once infection is established. The disease is associated with the fungus *Verticillium calophylli* (Wiehe) W. Gams, which is known from Mauritius and Central America as the causal organism of a vascular wilt of *Calophyllum* spp.

Introduction

Takamaka (*Calophyllum inophyllum* L.) is a common constituent of the coastal vegetation around the island of Mahé, providing shade at the edge of many of the best-known beaches, as well as being an important local timber tree. It also occurs as a littoral species throughout the Indo-Malayan region of the tropics from Seychelles to the western Pacific islands, where it is known as Alexandrian or Indian Laurel, growing mainly on deep coastal sands (Kadambi 1957). It is a handsome, ornamental evergreen tree of medium to large size, usually with a short, thick bole and spreading branches. It is very resistant to salt spray and brackish water, as well as being very wind-fast.

Few diseases have been reported on *Calophyllum* species apart from vascular wilts in Mauritius on *C. inophyllum* associated with a *Haplographium* species (Carver 1940; Wiehe 1939). This was identified at the Imperial (presently International) Mycological Institute and shown to be highly pathogenic on *C. inophyllum* and slightly pathogenic on *Eugenia glomerata* Lam. and *Mimusops maxima* (Poir.) Dubard by Wiehe (1939) and Carver (1940). Vascular wilt caused by the same fungus was also reported by Crandall (1949) in El Salvador killing 50% of *C. brasiliensis* Camb. plantations. He also confirmed its pathogenicity on this species (Anon. 1949; Crandall 1949). In addition Spaulding (1961) lists *Haplographium calophylli* Wiehe associated with *C. brasiliensis* and *C. tacamahaca* Willd. from unspecified countries. Similar fatal diseases of *C. inophyllum* have also been reported from India (Kadambi 1957) and Indonesia on trees up to 45 years old (Zwart 1927).

The causal fungus was first called *Cephalosporium calophylli* Crandall, however, Gams (1971) found that it was never validly published. He considered it to be synonymous with *H. calophylli*, which he transferred to the genus *Verticillium* as *V. calophylli* (Wiehe) Gams.

Dieback and mortality of Takamaka was first reported from Seychelles on the island of Mahé in March 1994 (Ivory & Andre 1996). The outbreak was

subsequently examined by the senior author with a view to diagnosing the causal organism, determining the extent of the outbreak and making recommendations to the Division of the Environment regarding control or eradication of the disease in Seychelles. the results of this study were subsequently submitted to the Government of Seychelles (Ivory 1994).

Methods

The disease was surveyed at the sites previously detected by the Forestry section's staff and along the sides of the perimeter road running around the island of Mahé on 11th and 12th August 1994, with all trees with noticeable dead foliage being examined. Samples of stems from 4 affected trees were collected on 11th August and stored in polythene bags for subsequent isolation attempts later the same day.

Attempts to isolate the causal organism into pure culture were made using small vials containing malt extract agar and paper discs impregnated with Tetracycline antibiotic. Small pieces of affected wood were taken aseptically from stem discs of 4 trees (one from Notholme Hotel and 3 from Sans Souci) soon after collection and placed in the vials. Pieces were also taken from discs of the same trees which had been incubated in damp paper for 3 days. Small pieces of stained vascular tissues from green wilted coppice shoots of a tree in Victoria Botanical Gardens were also cultured.

Further surveys have been made on the island of Mahé since August 1994 by Environment Division staff.

Results & Discussion

1. Disease symptoms: The first macro-symptoms are a wilting and drooping of the leaves on one or more branches with little discoloration of the dark green leaves. Subsequently, affected leaves and branches become necrotic and die. The disease may initially affect only one small branch, but appears to spread rapidly to the remainder of the tree causing death of the branch or the whole tree within a few months. A characteristic dark brown streaking is always present in the vascular tissues of all affected branches and is particularly noticeable in freshly wilted branches. these symptoms are all typical of vascular wilt diseases.

The stems of affected trees are rapidly attacked by small boring insects and various saprophytic stain fungi which cause the wood to become discoloured. Care was taken to distinguish between this discoloration and the vascular streaking described above,

2. Isolation of the causal organism: One fungal species was consistently isolated from all 4 trees sampled, especially from the fresh wood discs. This was confirmed as *V. calophylli* (synonym *H. calophylli*) at the International Mycological Institute (IMI 363649). The same fungus was also cultured from the green wilted shoots. no attempt was made to confirm the pathogenicity of the fungus in Seychelles. however, this species has been shown to be highly pathogenic to *C. inophyllum* and *C. brasiliensis* (Wiehe 1939; Carver 1940; Anon.

1949; Crandall 1949), giving rise to wilt symptoms and death of pole-sized trees in 6 and 8 weeks respectively. Other fungi of this genus are also well-known as the causal organisms of vascular wilt diseases in trees and herbaceous plants.

Isolated of *V. calophylli* grow rapidly on 3% Malt extract agar forming greyish-white, flat, spreading colonies which become almost black with age. Abundant hyaline conidia are formed on dark conidiophores. It does not store well on this medium at 15°C and was non-viable after 4 months.

Various other fungi were obtained from the stem discs which were incubated in damp paper for 3 days. these were all common saprophytes.

3. Epidemiology: Disease development seems to have taken place very rapidly in affected trees and branches, with mature trees being rapidly killed. Most affected trees were either still partly alive or completely dead when examined. However, most dead branches or whole trees appeared to have died quite recently as most still retained many of their leaves and most were at a similar stage of decay. However, a few dead branches on 2 trees were leafless and in a more advance stage of decay. These appeared to have been dead for about one year. additionally no old stumps were apparent at the disease foci located at Beau Vallon beach and Sans Souci forest station, which also suggests that the foci are of recent origin. However, infected coppice shoots on an old cut stump adjacent to an infected tree at Victoria Botanical Gardens could indicate either infection of the cut tree some years earlier, or recent infection of the shoots.

In August 1994 all the disease foci were small (<5 trees affected). New infections have arisen since then, but most appear to have developed as new foci rather than as expansions of existing foci.

Infection does not appear to be associated with tree pruning or stem damage, as this is unlikely to have been spread by such mechanical means. The dead stems of affected trees are, however, frequently infested with beetles. It is probable that one of these is the main vector giving rise to small scattered infection foci. This vector is probably very host specific, and probably forms an intimate relationship with the fungus. Infection is likely to take place on young green branches during feeding, at times of the year when adult beetles have just emerged from the stems. The beetles may also be preferentially attracted to trees which are under particular stress. Infection has been demonstrated in this way for this disease in Cuba via a scolytid beetle (Van Kerkhove, *pers. comm.* 1995). Spread through root grafts is also possible, but does not appear to be significant in Seychelles.

4. Distribution: In August 1994 affected Takamaka trees were found in only three localities on the islands of Mahé; namely, at Beau Vallon beach between Northolme Hotel and Le Meridien Fishermans Cove Hotel; at Victoria Botanical Gardens; and at 2 roadside sites near Sans Souci forestry station. Trees at all other sites along the coastal road were apparently healthy. Other forest localities were not visited by the consultant.

Subsequent surveys have detected further infection foci throughout the northern part of Mahé, with >300 trees affected by November 1995. Most of these

were felled and burnt; however, this does not appear to have checked the spread of the disease. Small infection foci have also been detected on the islands of Praslin and La Digue, forming a significant threat to the survival of the host tree on the latter and to its dependent endemic fauna.

Conclusions

The very restricted distribution of disease foci in Seychelles in August 1994, the subsequent spread of the disease into other areas and the absence of possible remains of older disease foci, suggest that the disease is of recent origin on this host in Seychelles and that the initial outbreak probably occurred on Mahé in 1993. the origin of this initial outbreak is however still unknown.

disease spread probably occurs via an insect vector, such as a scolytid beetle, in a similar way to the spread of Dutch Elm Disease in Europe. Spread by this means is very difficult to prevent, which could explain the apparent failure of the eradication campaign presently being conducted in Seychelles.

Few records of this disease have appeared in the literature since it was first recognised, despite the widespread distribution of the host. These have appeared as scattered outbreaks around the tropics and have apparently faced out of notice within a few years, without causing the complete demise of the affected host species. It is therefore possible that the disease is subject to natural controls which cause the fungus or its vector to decline, or that outbreaks are predisposed by critical outside influences.

Acknowledgements

The first author is very grateful to the Government of Seychelles for the invitation to study this disease and for the facilities provided by the Division of Environment during his visit in August 1994. He is also indebted to the British High Commission in Victoria for the provision of travel funds necessary for the above visit. This paper is published with the permission of the Division of Environment, Seychelles.

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Theridiosomatid spiders of the granitic islands of Seychelles (Araneae, Theridiosomatidae)

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Key words: Arachnida, *Andasta*, Silhouette

Abstract: Three theridiosomatid spiders are recorded from the granitic islands of Seychelles. The genus *Andasta* Simon, 1895 is revalidated. *Andasta benoiti* (Roberts, 1978) n. comb. is transferred from *Theridiosoma* O. Pickard-Cambridge, 1879 to that genus and a new species *Andasta siltie* n. sp. is described. A new genus *Zoma* n. gen. is created for *Zoma zoma* n. sp.

Introduction

Theridiosomatids are small araneoid spiders; total length 0.5-3 mm. They can be distinguished from all other spiders by having a small pit on both sides of the base of the labium. They have eight subequal eyes in two rows. Height of clypeus variable, usually more than twice the diameter of the anterior median eyes. Cephalic region frequently elevated. The sizes of cheliceral teeth are highly variable. Abdomen spherical, usually higher than long or wide and more or less overhanging the cephalothorax. Colulus relatively large. Female palpus without claw. Male palpus almost equal in size to prosoma, its cymbium with a minute lateral hook at the base. Epigyne usually a flat or domed plate. Characteristic of the vulva are a pair of spermathecae with a shared median wall.

Theridiosomatids live almost exclusively in wet or humid, shaded forest habitats. They make orb-like webs; the radii of the webs do not meet in the center. Papery egg sacs are suspended on a long stalk. Twelve genera and 64 species have been described.

All measurements cited below are in millimetres.

Genus *Andasta* Simon, 1895, revalidated genus

Andasta Simon, 1895: 918. - Type species by monotypy *Andasta semiargentea* Simon, 1895 from Sri Lanka.

Diagnosis: *Andasta* is clearly close to *Theridiosoma* O. Pickard-Cambridge, 1879 but may be distinguished from it by having a flat epigynal area while in *Theridiosoma* it is protuberant and hood-shaped.

Discussion: Coddington (1986) placed *Andasta* Simon, 1895 as a junior synonym of *Theridiosoma* O. Pickard-Cambridge, 1879 stating that its type species *Andasta semiargentea* Simon, 1895 does not differ substantially from his generic diagnosis for *Theridiosoma*. However, compared with the diagnosis of the other considered genera (Coddington 1986) that of *Theridiosoma* was left considerably broader and included the statement: "Without doubt some species groups of

Theridiosoma will merit generic status" (Coddington 1986: 61). At the same time he concluded that the cladistic relationships within *Theridiosoma* should be better understood before its splitting. The uncertainty over the cladistic relationships within *Theridiosoma sensu lato* is not accepted here as a valid justification for suppression of the names of its accepted component genera. In this particular case the very differently shaped epigynal areas have been considered to be sufficient to separate *Andasta* from *Theridiosoma*.

Andasta benoitii (Roberts, 1978), new combination
Theridiosoma benoitii Roberts, 1978: 935 (male & female).

Diagnosis: The males of *A. benoitii* may be distinguished from the other species of the genus by the long, pointed bulbal apophysis and the females by having broadly rounded posterior margin of the epigyne and long ovoid spermatecae laying rather close to it (Roberts 1978: Figs. 75-77 and 79-81).

Description: The species has been well described by Roberts (1978).

Distribution: Known only from Mahé and Praslin; Seychelles.

Andasta siltte, new species (Figs. 1-4)

Type: Female holotype from Seychelles; Silhouette, outside *Pisonia* forest, 1990, Justin Gerlach legnd. Deposited in the Zoological Museum, University of Turku (MZT AA 0.271).

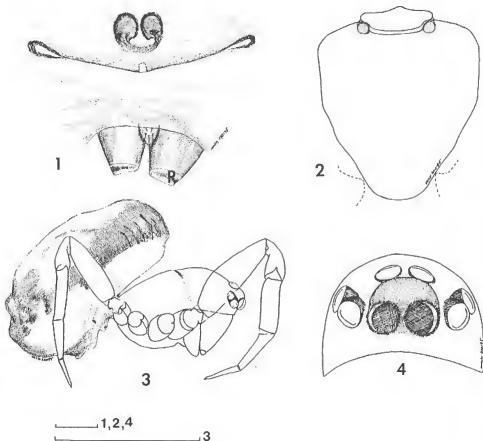
Diagnosis: The females (male unknown) of this species may be distinguished by the slightly convex, blunt tipped posterior margin of the epigynal area and long ovoid receptaculæ lying about their length from it.

Male: Unknown.

Female: Total length, not including chelicerae, 1.70. Carapace 0.77 long, 0.63 wide. Carapace, sternum, labium, and maxillae dirty white; cephalic area lightly suffused with black. Chelicerae pale yellowish. All coxae and femora dirty white; patella, tibiae, metarsus, and tarsus of leg I and II yellow brown but those of leg III and IV blackish brown. Anterior median eyes (AMEs) clearly larger than anterior lateral eyes (ALEs); posterior median eyes (PMEs) slightly smaller than AMEs, about one third of their diameter apart from each other. Clypeus relatively low, its height about 2/3 AME diameter. Labium wide and narrow. Sternal pits somewhat rectangular; ca. 3 times their diameter apart. Abdomen 0.63 long, 0.88 wide, 1.19 high. Abdomen flat, disk-like, overhanging cephalothorax. It is dirty white and surrounded by a relative wide blackish band; venter also dirty white. Colulus fairly

large, black. Posterior margin of epigyne slightly convex, bluntly triangular with small median transparent square. Receptaculac elongately ovoid, about their length from the posterior margin of the epigyne.

Distribution: Known only from Silhouette, Seychelles.



Figs. 1-4. *Andasta siltte* n. sp. (female). Original figure. Scale bar 0.1 mm.

1). Epigyne, colulus and spinnerets ventrally. - 2). Sternum and labium ventrally. - 3). Female dextrally. - 4). Eyes frontally.

Genus *Zoma*, new genus

Type species: Zoma zoma n. sp.

Diagnosis: At the present *Zoma* contains only its type species *Zoma zoma* and is diagnosed by the same characters as that species.

Etymology: The generic name *Zoma* refers to the belt of silvery corpuscles on the abdomen of the type species.

Zoma zoma, new species (Figs. 5-8)

Type: Female holotype from Seychelles; Silhouette, outside *Pisonia* forest, 1990, Justin Gerlach legend. Deposited in the Zoological Museum, University of Turku (MZT AA 0.291).

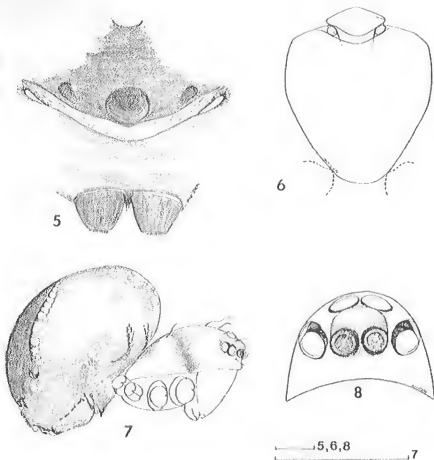
Diagnosis: Female (male unknown) of *Z. zoma* is distinguished from all other theridiosomatids by the flat, sharply pointed bluntly triangular epigynal plate with a wide, shallow median pit and smaller lateral ones.

Male: Unknown.

Female : Total length, not including chelicerae, 1.79. Carapace 0.74 long, 0.60 wide. Carapace yellow brown with broad lateral bands merging together in the ocular area. Chelicerae, sternum, labium, and maxillae yellow; sternum also with blackish edges. Labium about twice as wide as long. Sternal pits elliptical, a little more than twice their diameter apart. Coxae, femora, and patella pale yellowish; tibiae, metatarsi, and tarsi yellow brown, apex of tibiae and metarsi blackish; legs III and IV somewhat paler than legs I and II. Clypeus high, slightly more than AME diameter. Abdomen 0.77 long, 0.95 wide, 1.15 high; smoothly ovoid, overhanging carapace, dorsum with deep brown folium with black edges surrounded by a silvery glittering band of guanine corpuscles; otherwise dirty white variably suffused with black; areas of silvery corpuscles also frontally and lateroventally. Colulus small, black. Anterior spinnerets yellow brown, others more or less dirty white. Epigynal plate flat, sharply pointed bluntly triangular with wide, shallow median pit and smaller lateral ones.

Distribution: Known only from Silhouette, Seychelles.

Etymology: The specific name *zoma* denotes that this is the type species of the genus *Zoma*.



Figs. 5-8. *Zoma zoma* n. sp. (female). Original figure. Scale bar 0.1 mm.
 5). Epigyne, colulus and spinnerets ventrally. - 6). Sternum and labium ventrally. - 7). Female dextrally. - 8). Eyes frontally.

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Symphytognathidae (Arachnida, Araneae), a new spider family for the granitic islands of Seychelles

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Key words: *Anapistula*, *Patu*, Silhouette

Abstract: Two new symphytognathid species, *Anapistula seychellensis* n. sp. and *Patu silho* n. sp. are described. No members of the family Symphytognathidae has ever been recorded from the Seychelles before.

Introduction

The family Symphytognathidae includes tiny, lungless, orb- or sheet-web weaving spiders, among them are the smallest known spiders (the male of *Patu digua* Forster & Platnick, 1977 with a total length of 0.37 mm is the world's smallest known spider). Forster & Platnick (1977) have redelimited the family on the basis of synapomorphic characters and restricted it to include only those spiders which have (1) the chelicerae fused wholly or in part, (2) the female pedipalp reduced or absent, (3) the labium wider than long, and (4) the sternum broadly truncate posteriorly.

The family is widespread in the tropics of the southern hemisphere but due to their minute size they have rarely been collected. At present some 25 species (6 genera) are known but only three of them have been recorded from Africa (Griswold 1987, Baert & Jocque 1992).

All measurements cited below are in millimetres.

Genus *Anapistula* Gertsch, 1941

Anapistula Gertsch, 1941: 2. - Type species by original designation *Anapistula secreta* Gertsch, 1941 from Panama (Barro Colorado Isl.).

Diagnosis: Eyes in diads and pars cephalica only slightly elevated.

Description: The genus has been well described by Forster & Platnick (1977).

Anapistula seychellensis, new species (Figs. 1-4)

Type: Female holotype from Seychelles; Silhouette, Mon Plaisir, in litter, 20.12.1993, Justin Gerlach legend. Deposited in the Zoological Museum, University of Turku (MZT AA 0.290).

Diagnosis: *Anapistula seychellensis* is closely related to *A. benoitii* Forster & Platnick, 1977 from Zaire and *A. caecula* Baert & Jocque, 1993 from Côte-d'Ivoire. It differs from the first mentioned species by the much smaller spermathecae and longer lateral branches connecting them to the median duct and

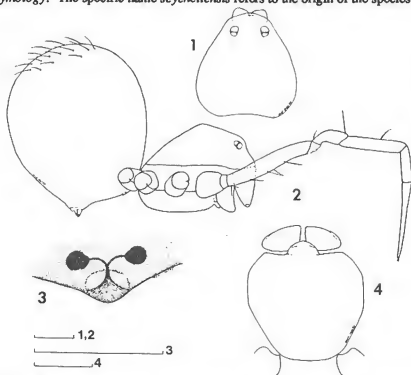
from the second one by the almost spherical spermathecae; the corresponding structures of *A. caecula* are kidney-shaped.

Male: Unknown.

Female: Total length, not including chelicerae, 0.64. Carapace 0.27 long, 0.22 wide. Abdomen 0.36 long, 0.36 wide, 0.42 high. Cephalothorax and legs pale brown. Abdomen somewhat pear-shaped, whitish; its sides and dorsum mottled with grey and clothed sparsely with long grey setae standing on brown spots. Four eyes in two diads. Sternum broadly truncate between hind coxae. Cheliceral teeth undiscernable. Legs fairly short and stout with some projecting macrosetae. Palp completely absent. Epigyne with two relatively small spermathecae connected by fairly long lateral branches to the short median duct, the first half of which is broadly conical.

Distribution: Known only from Silhouette, Seychelles.

Etymology: The specific name *seychellensis* refers to the origin of the species.



Figs. 1-4. *Anapistula seychellensis* n. sp. Original figure. Scale bar = 0.1 mm.

1). Female cephalothorax dorsally. 2). Female dextrolaterally. 3). Epigyne dorsally. 4). Sternum, labium, maxillae and hind coxae ventrally.

Genus Patu Marples, 1951

Patu Marples, 1951: 47. - Type species by original designation Patu vitiensis Marples, 1951 from Fiji.

Diagnosis: Chelicerae fused only near their base, six eyes in diads, and pars cephalica elevated.

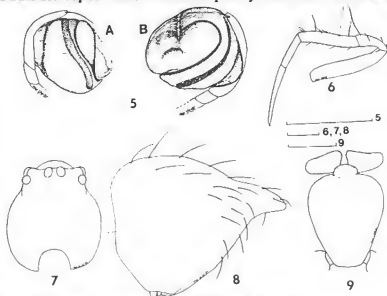
Description: The genus has been well described by Forster & Platnick (1977).

Patu silho, new species (Figs. 5-9)

Types: Male holotype and female paratype from Seychelles; Silhouette, Mon Plaisir, in litter, 20.12.1993, Justin Gerlach legend. Deposited in the Zoological Museum, University of Turku (MZT AA 0.289).

Diagnosis: *Patu silho* may be easily recognized by the pointed posterior protuberance on the globose abdomen.

Male: General appearance as in female (described below). Size somewhat smaller but exact measurements impossible as the specimen has suffered some damage during collection. Palpal cymbium long and narrow with one (or two) long, curved and translucent apical hairs. Embolus elliptically coiled with bulbous basal part.



Figs. 5-9. *Patu silho* n. sp. Original figure. Scale bar = 0.1mm.

5). Right male palp laterally (A) and mesially (B). 6). Left leg I of female laterally. 7). Carapace of female dorsally. 8). Abdomen of female laterally. 9). Sternum, labium, maxillae and hind coxae ventrally.

Female: Total length, not including chelicerae, 0.76. Carapace 0.31 long, 0.25 wide. Abdomen 0.47 long, 0.33 wide, 0.42 high. Carapace, sternum, labium and endites shining brownish black. Chelicerae black. Legs blackish except the proximal parts of metatarsi and tarsi pale, giving them a somewhat annulated appearance. Six eyes in three diads. Palp completely absent. Sternum pear-shaped, truncate between hind coxae. Cheliceral teeth undiscernable. Legs fairly short and stout with some projecting macrosetae; the one at the patella apex is extremely long. Abdomen globose with pointed posterior protuberance; blackish except for a large pale area on the underside of the posterior protuberance, clothed sparsely with long dark hairs.

Distribution: Known only from Silhouette, Seychelles.

Etymology: The specific name *silho* refers to the island of origin, Silhouette.

Discussion: It is quite possible that *Patu silho* is not a "real" *Patu* although the shape of the embolus is in some agreement with that of *P. vitiensis*. I have compared *P. silho* with a female of *P. vitiensis* from Fiji, Vitilevu, Longani (MZT, P.T. Lehtinen leg.) and its somatic characters are totally different to those of *P. silho*. However, the present material is so scanty that no SEM studies were possible. Therefore, it has been thought best to retain the wide generic concept of *Patu* as presented by Forster & Platnick (1977).

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The jewel beetles (Coleoptera; Buprestidae) of Seychelles

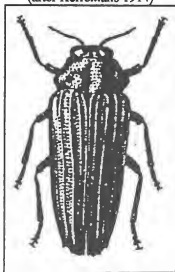
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Introduction

The jewel beetles (Family Buprestidae), also called splendour beetles and metallic wood-boring beetles, are hard-bodied, shiny, metallic-looking insects ranging in Seychelles from just over 4mm to nearly 30mm in length. The head is sunk deeply into the thorax, the eyes are relatively large and the antennae short and saw-toothed, with eleven segments. There are five tarsal segments on each leg. The larvae are legless and have a broad, flattened thorax. They bore galleries under the bark of trees.

Apart from specimens collected by the two Percy Sladen Trust expeditions in 1905 and 1908-1909 (Kerremans 1914) and the creation of the genus *Aldabrica* by Cobos Sanchez (1981), the jewel beetles of Seychelles appear to have been ignored by taxonomists and ecologists throughout most of the twentieth century. To facilitate further fieldwork on this group, I provide a simple identification key to the Seychellois species and summarise what is known of their distribution and biology.

Fig. 1. *Aldabrica fryeri*
(after Kerremans 1914)



NOTES

Key to the Buprestidae recorded from the granitic islands of Seychelles

1. Elytra with three transverse black bands *Agrilus owas*
 Elytra without transverse black bands 2.

2. Less than 15mm long from head to tip of abdomen.
 Dorsum blackish all over, including sides of pronotum and outer edges of elytra *Chrysobothris dorsata*
 Over 15mm long from head to tip of abdomen.
 Dorsum not blackish all over: sides of pronotum whitish or reddish, or outer edges of elytra smeared with yellow 3.

3. Posterior part of sides of pronotum reddish.
 Scutellum between bases of elytra clearly elongated, pointing backwards. Eyes less than 1mm apart at their closest *Belionota prasina*
 No part of pronotum reddish. Scutellum very small, indistinct to naked eye. Eyes over 1mm apart at their closest 4.

4. Sides of pronotum whitish. Pronotum distinctly crossed throughout its length by a thin line. Eyes about 2mm apart *Iridotaenia mahena*
 Sides of pronotum not whitish. Pronotum not completely divided length-wise. Eyes more than 2mm apart *Dicercomorpha alluaudi*

Key to the Buprestidae recorded from Aldabra

1. Over 5mm long, grossly punctate, pronotum angularly dilated about one-third of the way from the base *Aldabrica fryeri*
2. Less than 5mm long, finely punctate, pronotum rounded at the sides *Sponsor pilosellus*

NOTES

Notes on distribution and biology

1. *Agrilus owas* Castelnau & Gory, 1837

Kerremans (1914) reports that one specimen of this species was found at Cascade Estate on Mahé at around 250m above sea-level during the Percy Sladen Trust Expeditions. He does not state which of the two expeditions discovered it. This is the only species from the granitic islands not to have been found in recent years. It was originally described from Madagascar.

2. *Chrysobothris dorsata* Fabricius, 1787

In Seychelles this species has been recorded only from Mahé. During the first Percy Sladen Trust Expedition, in 1905, Gardiner collected it there, but Kerremans (1914) gives no indication of the numbers and exact localities involved. In 1909, during the second expedition, "several" specimens, including larvae and pupae from dead *Adenanthera pavonina* L. wood were given by "R.P. Dupont", presumably Rivals Dupont, then in charge of the Botanical Gardens (Lionnet 1983).

In October 1995 I observed a specimen of *C. dorsata* resting on a dead *Timonius sechellensis* Summerhayes in sunlight at 5:30pm at Ma Josephine, at about 300 metres above sea-level. In February 1996 I came across a dead specimen that had been trodden upon on the stairs of the television station of the Seychelles Broadcasting Corporation at Hermitage. Its elytra were partly opened, showing the dorsal surface of the abdomen to be a vivid metallic red, in sharp contrast with the blackish grey of the rest of the body.

Outside Seychelles, *C. dorsata* is reported to occur in the Mascarenes and Southern Africa (Kerremans 1914). In the Coleoptera collection of the Natural History Museum, London there are specimens from Mauritius, Réunion, Madagascar and the African mainland. Brown (unpublished note, 1953) found it at the end of March in an *Anacardium* (? *occidentale* L.) log in Mombasa, Kenya.

3. *Belionota prasina* Thunberg, 1789

In Seychelles, this species is also known only from Mahé. Two specimens, and larvae and pupae from dead mango (*Mangifera indica* L.) wood were collected in 1908-9 during the second Percy Sladen Trust expedition (Kerremans 1914).

In August 1995 I saw at least three specimens on a recently felled mango tree in bright sunshine at 1:45pm at Hermitage, on the wooded slope behind Victoria hospital at an altitude of 35 metres. In September 1995, one flew into my flat at Anse Nord-Est at night, presumably attracted to the lights. In February 1996 I observed one circling over a pile of recently felled rubber (*Hevea brasiliensis* (Willd. ex Juss.) Muell. Arg.) and cashew (*Anacardium occidentale* L.), again in bright sunlight, at 1:10pm at Marie Laure Estate (=Mount Simpson

NOTES

Estate), some 90 metres above sea-level. It landed on the main stem of a felled rubber sapling, crawled up and down it and then flew away. Similar behaviour, this time on a felled *Paraserianthes falcataria* (L.) Niels, was observed at 1:30 pm in April 1996 near the Fisherman's Cove Estate, at approximately the same elevation.

B. prasina has also been recorded from the Mascarenes, Indo-Malaysia and eastern Africa (Kerremans 1914). Tung (1983) gives its Asian range as "India to Indo-China, China, Taiwan, south to Peninsular Malaysia, Sumatra, Java, Borneo and Maluku (the Moluccas)". At the Natural History Museum, London there are specimens from Africa, Mauritius, Sri Lanka, the Andaman and Nicobar islands and the Asian mainland. Brown (unpublished note, 1953) found this species too at the end of March in an *Anacardium* (? *occidentale* L.) log in Mombasa, Kenya. Tung (1983) describes *B. prasina* as "dwelling among foliage". He considers it a very common beetle in Malaysia and says that it is frequently seen on the bark of kapok (*Ceiba pentandra* (L.) Gaertn.) and casuarina (*Casuarina equisetifolia* J.R. & G. Forster).

4. *Iridotaenia mahena* Fairmaire, 1891

This was the first jewel beetle to be reported from Seychelles. The description was based on a specimen from Mahé given to Fairmaire by Gustave Fallou. It has not been possible to verify if this is the specimen that according to Kerremans (1914) was collected by the French priest Philibert Meynet, who arrived in Seychelles in 1880 and died there in 1903 (Legrand 1965). During his stay in Seychelles in 1892, Alluaud collected *I. mahena* on La Digue (Kerremans 1893). He visited the island during the last week of April (Alluaud 1894). Gardiner and Scott collected the species on Mahé during the 1905 and 1908-1909 Percy Sladen Trust expeditions respectively (Kerremans 1914).

On Mahé, I have frequently observed *I. mahena* resting on foliage exposed to bright sunlight at Marie Laure Estate, from 40m to 90m above sea-level (dates not recorded). I have come across the species on Silhouette as well. I observed one specimen resting on *Ficus lutea* Vahl. foliage not far from the beach at Anse Mondon in July 1990 around the middle of the day and on unidentified vegetation some 150m above the coast of La Passe (date not recorded).

This species appears to be endemic to Seychelles. According to Fairmaire (1891), it resembles *I. mirabilis* from Borneo.

5. *Dicercomorpha alluaudi* Kerremans, 1893

This species was first collected by Alluaud on La Digue at the end of April 1892 (Alluaud 1894). It was not found by either of the Percy Sladen Trust expeditions at the beginning of the century. Apparently the species was never collected again until more than a century after the type series: a beetle found by Josie Michaud-Payet on the second-floor balcony of the television station of the

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Seychelles Broadcasting Corporation at Hermitage on 4th October 1994 was identified by me as *D. alluaudi*!

This species also appears to be endemic to Seychelles. Kerremans (1893) states that it closely resembles *D. farinosa* Thom. from the Andaman islands. He adds that the genus *Dicercomorpha* is found mainly in the "Indo-Malayan and Malayo-Australian regions", with one species in Fiji. Alluaud (1894) considers that the distribution of the genus *Dicercomorpha* is more or less like that of leaf insects of the genus *Phyllium*. He uses the presence of both in the granitic Seychelles as evidence of the Oriental affinities of the islands' insect fauna.

6. *Aldabrica fryeri* (Kerremans, 1914)

This species was first collected on Île Michel, at the eastern end of Aldabra lagoon, in October 1908, during the second Percy Sladen Trust expedition, by Fryer (Kerremans 1914). It was originally described as *Pseudocastalia fryeri*. Cobos Sanchez (1981) created the genus *Aldabrica* for the species. It was collected by suction trap on Île Picard by F. Joplin in December 1972 (specimen in the Natural History Museum, London).

7. *Sponsor pilosellus* Kerremans, 1914

This species was first collected by Fryer at "Takamaka" on Aldabra (there are several localities in the eastern part of Grande Terre island that have "Takamaka" as part of their name) in November 1908 during the second Percy Sladen Trust expedition. It may not be the only species of *Sponsor* to be found on Aldabra. During the 1967-1969 Royal Society expedition to the atoll, Hutson and Cogan collected two specimens on Île Michel. These were determined by B. Levey as "*Sponsor* sp. near *S. oblongus* of Mauritius" (data label with specimens in the Natural History Museum, London). The Natural History Museum has specimens of other *Sponsor* species from Mauritius, Rodrigues, Réunion and Madagascar.

Conclusion

Further research should be carried into the biology of all the species. For conservation purposes, it is necessary to ascertain the ecological requirements of the endemic species in particular. Also, it is necessary to verify which species occur on Praslin, the second largest granitic island of Seychelles.

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Table 1. Known distribution of Buprestidae in Seychelles

	Mahé	La Digue	Silhouette	Aldabra		
				Michel	Picard	Takamaka
1. <i>Agrilus owas</i>	+					
2. <i>Chrysobothris dorsata</i>	+					
3. <i>Belionota prasina</i>	+					
4. <i>Iridotaenia mahena</i>	+	+	+			
5. <i>Dicercomorpha alluaudi</i>	+	+				
6. <i>Aldabrica fryeri</i>				+	+	
7. <i>Sponsor pilosellus</i>				+?		+

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NOTES

New sites for some native plants of Seychelles

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Introduction

According to Friedmann (1994), the flora of the granitic islands of Seychelles includes some 200 native species of angiosperms or flowering plants, of which around 70 are endemic. Many of these native plants are extremely local in distribution. Proctor (1974) and Friedmann (1986 & 1994) have provided useful distribution data, while the Nature Protection Trust of Seychelles has introduced a scheme (1993) for the mapping of species distributions. During recent fieldwork on Mahé, Praslin and Silhouette, new sites have been discovered for several plants.

1. *Wielandia elegans* Baillon

Friedmann (1994) reports that on Mahé this species has become rarer and has been found recently only at Anse Forbans and Glacis. In 1995 I found at least three specimens in a boulder field at Marie Laure Estate (=Mount Simpson Estate) in Bel Ombre district, at an altitude of around 80 metres above sea-level. The surrounding vegetation is made up largely of introduced *Hevea brasiliensis* (Wild. ex A. Juss.) Muell. Arg., *Adenanthera pavonina* L. and *Cinnamomum verum* Presl., with *Nephrosperma vanhoutteana* (Wendl. ex van Houtte) Balf. as the main other native species present.

On 24th March 1996 I discovered 40 individuals of *W. elegans* growing on the western side of the La Rosière clocktower, on the steep slope to the north of the Cathedral of the Immaculate Conception and the Roman Catholic priests' residence in Victoria, 10-20m above sea level. The plants ranged from 2.5m high to small seedlings with only a few leaves and the remains of the seed still attached, with most in the intermediate range. A few immature fruits were present on the two largest bushes. Some of the plants had been cut at some point, and had resprouted. Several such damaged individuals were infested with termites. Most of the surrounding vegetation was made up of introduced species: *Albizia lebbek* (L.) Benth., *Sandoricum koetjape* (Burm.f.) Merrill, *Adenanthera pavonina* L., *Cinnamomum verum* Presl., *Litsea glutinosa* (Lour.) C.B. Robins., *Memecylon caeruleum* Jack, *Ochna* sp., *Anacardium occidentale* L., an unidentified palm that grows in clumps and *Syngonium podophyllum* Scott.

The only native plants seen in the vicinity were: *Canthium bibracteatum* (Baker) Hiern, *Dracaena reflexa* var. *angustifolia* Baker (one very small individual) and the fern *Phymatosorus scolopendria* (Burm.f.) Pichi-Serm.

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2. *Ipomoea venosa* (Desr.) Roem. & Schult.

According to Friedmann (1994), on Mahé this species was last collected by Boivin and Horne, who visited Seychelles in the 19th century. He also describes it as a species of the open vegetation of low-altitude "glacis" near the coast. On 26th November 1995, Philippe Boullé, Dr. Maureen Kirkpatrick and myself discovered three specimens of *I. venosa* growing in pockets of humus caught in clefts in the cliff face of Ma Joséphine, at about 250 metres above sea-level.

At the start of December 1995, I encountered at least two specimens, one of them in flower, on Silhouette on the lower La Passe - Grand Barbe path, at an altitude of around 370 metres. The above records show that *I. venosa* is not confined to the coastal zone.

Some observations on the species are worth mentioning here. The Silhouette specimens referred to above were growing between rocks. One of these had slipped, exposing the root system of one plant. This was seen to consist of a swollen root tuber bearing smaller roots. Examination of the stem showed that it had been broken off and had resprouted several times.

Regrowth can be extremely fast in the early stages. A tuber was placed in a pot of soil on 6th December 1995. By 24th December it had grown a shoot 31 cm long. A week later, on 31st December, the shoot was 88 cm long. It had grown by 57 cm in one week, the average rate of growth being therefore over 8 cm per day or over 0.3 cm per hour! Unfortunately, it was not possible to continue regular observations on the plant, but it was noticed that the rate of growth fell off sharply once the first mature leaves had appeared.

Finally, a piece of shoot broken off from a plant was found to grow readily when planted in a pot of soil. It did not bear roots originally and was obviously able to develop adventitious roots from the nodes.

3. *Impatiens gordonii* Horne ex Baker

4. *Psychotria silhouettae* F. Friedmann

Friedmann (1994) states that *I. gordonii* is known to survive in only two localities on Mahé and that the species should be considered as being on the verge of extinction. At least one substantial population is now known to occur on Silhouette as well. Dr. Maureen Kirkpatrick and myself discovered it on 15th June 1995 at around 300 metres above sea-level in the Anse Mondon river valley. From preliminary surveys carried out then and during a subsequent visit in December 1995, it appears there are several hundred individuals, growing in the humus on the boulders that are piled into the valley. On each occasion, at least half the plants were in flower. Some flowers were slightly tinged with pink, especially along the edges of the petals. All the plants appeared to branch only at ground level, not higher. One specimen had twenty shoots, the largest of which was a metre long.

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On my second visit to the site, on 2nd December, I noticed that at 12:30pm most plants were exuding water, presumably from hydathodes along the leaf margins. Caterpillars of a hawkmoth, resembling those of *Hippotion eson* (Cramer, 1779), were observed on some plants. A more detailed report on the insects found in the vicinity is in preparation.

Other vegetation growing in the area included (in approximate order of decreasing abundance):

Native: *Heritiera littoralis* Ait.

Phoenicophorium borsigianum (K. Koch) Stuntz

Terminalia catappa L.

Barringtonia racemosa (L.) Spreng.

Northea hornei (M.M. Hartog) Pierre

Tarena sechellensis (Baker) Summerh.

Ludia mauritiana var. *sechellensis* F. Friedmann

Pseuderanthemum tunicatum (Afz.) Milne Redh.

Dracaena reflexa var. *angustifolia* Baker

Psychotria silhouettae F. Friedmann

Cocos nucifera L.

Asplenium nidus L.

Introduced: *Clidemia hirta* (L.) D. Don

Hevea brasiliensis (Wild. ex A. Juss) Muell. Arg.

Paraserianthes falcata (L.) Niels

Adenanthera pavonina L.

Cinnamomum verum Presl.

Theobroma cacao L.

Syzygium aromaticum (L.) Merr. & Perry

Cola nitida (Vent.) Schott & Endl.

Musa sapientum L.

The presence of *Psychotria silhouettae* at this site is especially noteworthy, since only three or four specimens of this extremely rare plant were known previously, all in the *Pisonia sechellarum* F. Friedmann forest discovered by Friedmann in 1982 at the very top of the Anse Mondon river valley (Friedmann 1994). Two specimens were sighted near the *I. gordonii*.

5. *Achyropermum sechellarum* Baker

6. *Acacia pennata* (L.) Willd.

These are two components of the *Pisonia sechellarum* forest community on Silhouette (Friedmann 1986 & 1994). *Achyropermum sechellarum* has been found in "only three or four sites", while *Acacia pennata* is known to occur "on the slopes towards Jardin Marron" as well (Friedmann 1994). In December 1995 I discovered both species growing together on boulders on the southern/eastern side of the lower La Passe - Grande Barbe path, at about 350 metres above sea level,

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west of the Gratte Fesse - Mont Corgat ridge. The surrounding vegetation included *Asplenium nidus* and other ferns, *Procris insularis* H. Schroter, *Begonia seychellensis* Hemsl., *Psychotria* sp., *Phoenicophorium borsigianum* (K. Koch) Stuntz, *Roscheria melanochaetes* (Wendl.) Wendl. ex Balf., *Grisolea thomasetii* Hemsl., *Mucuna gigantea* (Willd.) D.C., *Adenia gummiifera* (Harv.) Harms, *Dracaena reflexa* var. *angustifolia* Baker and *Musa sapientum* L.

The largest of three particularly thick *Acacia pennata* measured 6.5cm in circumference. As the plants drape over rocks, they send out adventitious roots into pockets of humus and sprout shoots there. Some of the latter have become separated from the mother plants by the rotting away of the connecting "runner". The tallest *A. pennata* disappeared into the foliage of a *Morinda citrifolia* L. and *Adenanthera pavonina* L..

7. *Secamone schimperiana* (Hemsl.) Klack.

Friedmann (1994) gives only two sites on Praslin for this rare liane, which also occurs on Mahé and Curieuse: the Vallée de Mai and Anse Petite Cour. In April 1995 Karl Fleishmann and Maureen Kirkpatrick discovered a new site for the species amid the open scrub above Anse Matelot, at an altitude of about 100m. I visited the site with Kirkpatrick in January 1996 and counted at least seven plants growing over *Dillenia ferruginea* (Baillon) Gilg and *Memecylon eleagni* Bl.

8. *Malaxis seychellarum* (Kraenzl.) Summerhayes

This hygrophilic orchid is most often encountered in the "mountain mist forest" above 500 metres. In January 1996 Philippe Boullé showed Dr. Maureen Kirkpatrick and myself a small patch of this species growing in a moist, sheltered area between granite boulders and under a large *Ficus lutea* Vahl. on the cliff of Ma Joséphine at about 300 metres above sea level. This is the lowest point at which any of us has seen the species.

Conclusion

The above finds show that small populations of many rare plants are scattered over a wider area of the granitic islands of Seychelles than is generally believed. Cliffs and boulder fields, in particular, should repay further investigation.

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NOTES

The sheath-tailed bat *Coleura seychellensis* Peters, 1868 (Chiroptera: Emballonuridae) rediscovered on Silhouette island

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Introduction

There is no recent first-hand account of the rare sheath-tailed bat *Coleura seychellensis* Peters, 1868 on Silhouette island (Matyot 1995). The species is now known still to occur there: Flavien Joubert discovered two occupied roosting sites at La Passe on July 13th 1995 (Joubert 1996). While his detailed report is in preparation, he has given permission for his findings to be summarised here. Dr. Maureen Kirkpatrick and I visited one of the roosts on 29th November 1995.

Summary of findings

Of the two occupied roosts that Joubert discovered at La Passe, Roost A is a cave in a boulder field. According to data supplied by Joubert, it is at around 30m above sea level in an area of mixed vegetation including native palms and exotic species. He counted 14 bats present. This is apparently the site also examined by myself and Kirkpatrick. We observed at least 8 bats, but did not venture very far inside what seemed to be a system of interconnecting caves and did not stay for very long for fear of unnecessarily disturbing the animals. They flew around briefly while we were there, uttering distinctive high-pitched cries before landing again on the almost horizontal ceiling.

At Roost B, another cave some 20m further uphill, Joubert found 11 bats.

He also explored caves in the coastal area of Grande Barbe and Pointe Coco, but although bat guano deposits were found inside one cave in each of these two localities, no bats were present.

Joubert sampled the flying insects present on the coastal plain of La Passe and analysed the faecal pellets of *C. seychellensis* to identify prey remains. He found that although Diptera and Hymenoptera were the most abundant insects, the bats seemed to prefer Coleoptera and Lepidoptera. By analysing the vocalisation of *C. seychellensis*, he calculated that insects less than 5.5mm long are below the prey detection limit.

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Conclusion

The re-discovery of *C. seychellensis* roosts on Silhouette is further evidence of the importance of that island as a "biodiversity hot spot". While further research is needed to elucidate the biology and ecology of *C. seychellensis*, our knowledge of the species is expected to improve considerably as a result of Joubert's fieldwork. It may be added here that in 1994 he encountered foraging bats along the path to Anse Major and near La Gogue Dam and, in 1995, he discovered a bat guano deposit, but no bats, inside a cave at La Réduit, Takamaka (all localities on Mahé island).

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The rediscovery of *Pelusios seychellensis*

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In the western Indian Ocean the terrapin genus *Pelusios* is represented by three species on Madagascar and in Seychelles, with introduced populations in other island groups. The Seychelles populations are taxonomically distinct, two as endemic sub-species (*Pelusios castanoides intergularis* Bour, 1983 and *P. subniger parietalis* Bour, 1983) and the third as an endemic species (*P. seychellensis* (Siebenrock, 1906)) (Bour 1983 & 1984). Of these *P. seychellensis* is only known from three specimens collected by A. Brauer on Mahé in 1895 (Bour 1984; Siebenrock 1909). The lack of subsequent records has raised concern over its survival and all three species are believed to be endangered due to recent dramatic declines in the area and quality of suitable habitat (Gerlach 1996).

In November 1994 a terrapin was found crossing a road at 8am at Le Niol, Mahé by R.&G. Gerlach. It was photographed and released. The photographs were examined by us in February 1996 and recognised as *P.*

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seychellensis. This identification is based on descriptions and figures given by Bour (1983 & 1984) and has been confirmed by R. Bour (*pers. comm.*).

Description

The 1994 specimen was an adult female (carapace length 265mm, width 116mm, height 92mm). The carapace is distinctive in having a low keel from the posterior part of vertebral 1 to the anterior of vertebral 5 (restricted to vertebrals 4 and 5 in *P. castanoides* and absent from *P. subniger*). Vertebrals 1-3 and 5 are broader than long and vertebral 4 is as broad as long (as in *P. subniger*, but in *P. castanoides* vertebrals 1-4 are at least as long as broad). The width of the two first marginals is almost equal to anterior width of vertebral 1 (these are smaller in both other species). Colour uniformly black.

The plastron is 158mm long. The gulars are separated by a relatively small intergular: the anterior gular margin is twice as wide as the anterior intergular margin and the intergular is 1.5 times as long as broad. In the other species the intergular is larger and broader. The plastron is predominantly black, with yellow patches restricted to worn areas and along hinge (it is yellow in the other species).

The upper jaw is unserrated and unhooked. Postocular and masseteric scales are narrowly separated by a moderately sized supralabial scale. The dorsum of the head is brown and the sides, tympanum, lower jaw and neck are pale yellow. Iris pale blue-grey (darker in the other species). The limbs and tail are yellow.

Conservation prospects

The confirmation that *P. seychellensis* survives on Mahé makes research into the status of Seychelles terrapins of great importance. The Nature Protection Trust of Seychelles is developing a conservation plan for the three species based on a population survey, this project was shortlisted for the 1996 Whitley Award for Animal Conservation.

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NOTES

Native or introduced plant species ?

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The recent publication of the dicotyledon volume of Friedmann's *Flore des Seychelles* (1994) clarifies a number of taxonomic problems. The distribution data and taxonomic discussions identify a large number of species as indigenous or endemic components of the flora. However, in addition to these species several others have been suggested to be indigenous, although regarded by Friedmann (1994) as introductions. These are discussed below:

Casuarinaceae

Casuarina equisetifolia J.R. & G. Forster

This species has been widely dispersed from its centre of distribution in south-east Asia. Although most populations are introduced those of the Seychelles islands are often considered to be indigenous (Sauer 1967). The first record is from 1768 (Dufresne 1768) and it is one of the species sometimes suggested to have been introduced by Melanesians at an unspecified date (Procter 1984b), as such it should be regarded as indigenous, or 'substantially native' (Gerlach 1994).

Malvaceae

Hibiscus surattensis L.

A widespread species from Madagascar, east Africa and the Comoros to south-east Asia. First recorded in 1874 (Baker 1877) and considered to be indigenous by Robertson (1989). It appears to have originated from India and may have been introduced as a weed, although its introduced status is not certain.

Rosaceae

Rubus rosifolius Smith

Considered indigenous by Summerhayes (1931) and Robertson (1989). Abundant in Seychelles since before 1866 (Summerhayes 1931), widely dispersed by birds and mammals, possibly a native Asiatic component.

R. fraxinifolius Poirét, 1804

This may have a similar status to *R. rosifolius* although it has only recently been recognised in Seychelles. Deliberate introduction of this species is unlikely, given the poor taste of the fruit.

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Mimosaceae

Adenanthera pavonina L.

An Asiatic species also present in the Mascarenes and Seychelles. It has been suggested to have been introduced before the exploration of the islands (Procter 1984b). There is a clear description of this species in Seychelles from 1768 (Dufresne 1768) and it should be considered to be indigenous or 'substantially native'. Previously suggested to be a native species by Baker (1877) and Robertson (1989).

Papilionaceae

Teramnus labialis (L.) Spreng.

Regarded as indigenous by Summerhayes (1931) and Robertson (1989). A pantropical species recorded since 1874 (Summerhayes 1931). Probably indigenous.

Melastomataceae

Melastoma malabathricum L.

This widespread Asiatic species was regarded as indigenous by Summerhayes (1931) and Robertson (1989). It has been recorded since 1841 (Summerhayes 1931) and is probably a native Asiatic component dispersed by migrating birds (as with *Rubus* spp.).

Combretaceae

Terminalia catappa L.

A widespread trees species generally considered to be indigenous (Robertson 1989; Sauer 1967; Summerhayes 1931). Doubt as to its status was expressed by Friemann (1994) who considered it to be probably indigenous. East African populations have been classed as introduced in contrast to the classification of Madagascan ones as indigenous. Procter (1984b) suggested that natural colonisation was possible but unlikely and that introduction by Melaneseans several centuries ago accounted for its presence. The earliest record of the species in Seychelles is from 1768 (Dufresne 1768), accordingly it should be considered indigenous.

Loganiaceae

Strychnos spinosa Lam.

Indigenous according to Summerhayes (1931) and Robertson (1989), recorded since 1874 (Summerhayes 1931). An African species with a long history in the Mascarenes. Probably indigenous, although there is little evidence for or against the possibility of it being an introduction.

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Convolvulaceae

Merremia peltata (L.) Merr.

Indigenous (Summerhayes 1931; Robertson 1989) or possibly indigenous (Procter 1984a); recorded since 1840 (Summerhayes 1931). Early accounts of its distribution give Madagascar-Mascarenes-Seychelles, a distribution pattern typical of native species. It is probably indigenous.

Verbenaceae

Phyla nodiflora (L.) E. Greene

A littoral species, widespread in the western Indian Ocean. Classified as indigenous by Summerhayes (1931), Sauer (1967) and Robertson (1989). It has been recorded since 1841 (Summerhayes 1931) and is probably indigenous.

Vitex trifolia L.

Considered indigenous by Sauer (1967). This species is frequently cultivated and its distribution indicates that it is almost certainly introduced.

Oleaceae

Ximinea americana L.

Considered indigenous by Summerhayes (1931), Sauer (1967) and Robertson (1989). The only records are from the strand line and the species may have been a natural colonist. It is not known to survive in Seychelles at present.

Acanthaceae

Asystasia sp. B.

Considered introduced by Friedmann (1994) although not fully identified. Introductions of *Asystasia gangetica* were recorded in 1905 but specimens of sp. B. date from 1868 (Summerhayes 1931). Possibly native, depending on final identification.

Justicia gendarussa Burm.

Indigenous according to Summerhayes (1931) and Robertson (1989), recorded since 1841 (Summerhayes 1931). An Indo-Pacific plant of marshy ground, probably indigenous and spread through stranding and bird migration.

Rubiaceae

Morinda citrifolia .

Considered to be a possible introduction by Friedmann (1994). Deliberate or accidental introduction of this evil smelling fruit seems unlikely, stranding and local dispersal by fruit bats would seem a more likely origin. Considered indigenous by Sauer (1967).

NOTES

Monocotyledons

Similarly disputed origins have been proposed for a number of monocotyledons (the coconut *Cocos nucifera* L. being the most obvious example), in the absence of an authoritative taxonomic review of the species present it is not practical to consider the status of these taxa.

Other introduced dicotyledons

There is a further recent introduction omitted by Friedmann (1994). The 'Jamaican cherry', *Muntingia calabura* L. (Flacourtiaceae), was first observed in Seychelles in 1990 when it colonised the reclamation on the east coast of Mahé. A specimen from the Roche Caiman Bird Sanctuary was identified as this species in 1994 (Nature Protection Trust of Seychelles 1994). This South American species has been widely introduced around the tropics and probably colonised Seychelles on machinery imported in connection with the dredging and reclamation. It was an obvious component of the reclamation vegetation in 1990-4, since then *Casuarina equisetifolia* has overshadowed the species and it is now infrequent, being restricted to a few trees under a dense canopy of *C. equisetifolia*. This introduction will probably prove to be temporary. It is described below and shown in Fig. 1.:

Muntingia calabura L.

Small unarmed tree to 6m, trunk to 25cm diameter, smooth bark, branches pubescent. Leaves alternate, elliptical, pointed at tip, slightly assymetrical, rounded at base, 5-10cm x 2-4cm, with serrated margins, pubescent. Petiole 3-6mm long. Flowers axillary, solitary or paired, pedicel 2-4cm. Sepals 4-5, green-white, 4-5mm long. Petals 4-5, white, 7-10mm long, oboval to deltoid. Stamens numerous (10-100), 3-5mm long. Pistil 4mm long, stigma broad. Fruit a drupe 8-14mm diameter.

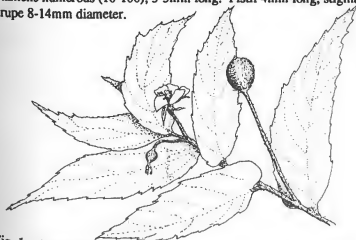


Fig. 1. *Muntingia calabura*.

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This can be added to the key to Flacourtiaceae in Friedmann (1994 p. 192):

- | | | |
|----|--|-------------------|
| 1. | Leaf margins entire or weakly sinuous | <i>Ludia</i> |
| | Leaf margins toothed | 2. |
| 2. | Spiny | <i>Flacourtia</i> |
| | Not spiny | 3. |
| 3. | Branches flattened with longitudinal crest, smooth | <i>Aphloia</i> |
| | Branches cylindrical, no longitudinal crest, hairy | <i>Muntingia</i> |

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Rainfall patterns - an overlooked ecological influence

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Periodic cycling of weather patterns in the western Indian Ocean were first noted by Aspin (1976) and subsequently discussed in detail by Stoddart & Walsh (1979). These publications demonstrated the existence of regular cycles of high and low rainfall at meteorological stations throughout the region, although cycles are less apparent in the coraline islands where rainfall is extremely low and erratic. Examination of the rainfall data for Seychelles demonstrates the continuance of the reported cycles and suggests some interesting correlations with ecological data.

Cyclical rainfall in Seychelles takes the form of alternating wet and dry phases. In wet phase years annual total rainfall is above the long term mean (2400mm) whereas dry phase rainfall remains below 2400mm. These phases are of equal length (approximately 16 years, range 14-20 years). Dry phases occurred in 1905-22, 1938-58 and 1975-89. A 16 year cycle is also apparent in the available census data for Seychelles magpie robins (*Copsychus sechellarum* Oustalet, 1878) on Fregate island. Accurate censuses date from 1974 although there are subjective estimates from 1959 (Gretton 1990-92; Komdeur 1988-90; McCulloch 1992-95), there are insufficient data to demonstrate long term periodicity but population and rainfall peaks coincide. Rainfall data from Fregate only date from 1990 (Gretton 1990-2; McCulloch 1992-5) but these 5 years of data are consistently 20% lower than the corresponding values for Mahé. In the

following analysis Fregate rainfall has been reconstructed for the years 1959-89 as 80% of the Mahé values for those years (Fig. 1.). From this it can be seen that development of the 1974-89 dry phase was accompanied by a dramatic decline in the magpie robin population and the recovery in 1990 by increased rainfall



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resulting from the start of the current wet phase. A lack of correspondence prior to 1974 is probably due to numbers being estimated subjectively by different observers. Linear regression of the 1975-95 data is significant ($F=16.78$, $P<0.001$).

The correlation indicates that rainfall is an important underlying influence on the population. The recovery since 1990 appears to result from increased survival of chicks to one year (McCulloch 1993); other demographic factors fluctuate and do not correlate to the population increase (Table 1.). During this period territory size has also decreased slightly. This combination of factors can be related to rainfall patterns by food availability. Invertebrate sampling studies have not detected an increase in invertebrate abundance (Gretton 1990-2; McCulloch 1992-5) but, as demonstrated elsewhere, rainfall influences distribution, not numbers (Gerlach 1995). During dry weather many invertebrates adopt a patchy distribution, congregating in damp areas. This effect of rainfall on prey distribution is shown on Fregate by the significant negative correlation between rainfall and the variance of invertebrate numbers (Spearman's $r=0.95$, $n=12$, $P<0.001$; data from McCulloch 1992-5). Clumped prey distributions reduce predatory efficiency (Hassell & May 1974), consequently dry years, with clumped prey, will have less food availability than wet years. Food availability will influence adult survival and territory size to some extent but will be most important to young birds with little foraging experience (yearling foraging efficiency is half of adult efficiency - Komdeur 1988). The Magpie Robin Recovery Plan's supplementary feeding of nestlings and fledglings will mask any influence on these stages but survival to one year will remain heavily influenced by prey distribution and hence rainfall.

From this it appears that much of the increase in magpie robin numbers since 1990 results from improved climatic conditions. With the 16 year cycle dry conditions should return in approximately 10 years, when conditions for magpie robin recruitment will deteriorate. With this scenario, during a dry phase the carrying capacity of Fregate is probably much closer to the 21 individual minimum of 1974-89 than the current high numbers. With periodic fluctuations of rainfall population bottlenecks will recur with severe implications for groups introduced to Cousin, Cousine and Aride. Despite the dramatic success of the Cousin introduction none of these islands can support a viable population in a dry phase. For population stability much larger areas need to be occupied, preferably on islands retaining extensive areas that are always subject to high rainfall. On these islands population fluctuations are inevitable on the dry plateaux but these would be buffered by more stable populations in damp lowland and mid-altitude forests.

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Table 1. Magpie robin demography

(data from Gretton 1990-92; Komdeur 1988-90; McCulloch 1992-95)

	Year							
	88	89	90	91	92	93	94	95
Number (December)	20	22	21	22	27	39	47	51
Adult survival (%)	80	84	80	90	90	95	89	96
Eggs per pair	1.7	1.5	1.5	3.0	2.0	3.5	?	?
Hatching rate (%)	72	75	59	57	92	55	?	?
% chicks fledged	40	78	57	62	73	70	80	80
% independent	50	70	75	61	88	100	90	63
% survival to 1 year	0	56	67	80	100	100	100	-

This demonstration of the importance of habitat and abiotic factors makes it worth re-examining data behind the view that the distribution of magpie robins (and other species) results from predation by introduced cats and rats. All available data on the last definite record of magpie robins, earliest records of predators and approximate dates of complete lowland forests clearance are summarised in Table 2. Of the 9 islands with definite records 2 have no useful data subsequent to 1768 (St. Anne and South-east). On the remainder magpie robins coexisted with cats and rats for a considerable number of years (over 70 years in 3 cases). Even on the small island of Fregate they coexisted for 31 years. On two other islands there may not have been any overlap between cats, rats and magpie robins at all. Two records are particularly important as the claim that cats and rats have been the primary cause of extinction rests upon them (Watson 1984). On Aride magpie robin extinction is generally reported to have followed some 10-15 years after the introduction of cats whereas, in fact, the last record of magpie robins is 13 years before the cat introduction (its survival into the 1930s being only unsubstantiated hearsay evidence quoted by Vesey-Fitzgerald 1940) and the absence of specimens from 1907 (when Lord Walter Rothschild's collector visited the island) suggests that the population became extinct 11 years before cats were introduced. Alphonse, by contrast, is the only island where extinction caused by cats can be supported; the extinction followed 5-15 years after cat introduction was reported to have occurred. There are only three records of magpie robins from Alphonse, the first was Abbott in 1892 who reported its introduction (Ridgway 1895), the second is the imprecise report of its abundance in 1936 (Vesey-Fitzgerald 1940) and the last sighting was of a single bird in 1962 seen by Lousteau-Lalanne (Gaymer *et al.* 1969). The exact date of introduction is unknown but it was probably shortly after the island was settled and the coconut plantation established - before Abbott's visit. The plantation appears to have remained unchanged until after the magpie robins extinction with the only change being the introduction of cats at an unknown date in the 1950s (Gaymer *et al.* 1969). With the relatively simple environment of a coconut plantation the potential for heavy

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Table 2. Distribution, predator and habitat data from magpie robin islands

(Bets 1940; Bullock 1989; Collar & Stuart 1985; Gaymer *et al.* 1969; Lucking & Ayrton 1996; Malavois 1768; Nevill 1868; Newton 1867; Nicoll 1906; Oustalet 1878; Pike 1871; Ridgway 1895; Scott 1912; Vesey-Fitzgerald 1940; Watson 1984; Rothschild collection. - American Museum of Natural History)

Island	Last record	Extinction	Cats present	Rats present	Overlap	Lowland clearance
Mahé	1867	1871-1878	<1787	<1787	84-91	complete by 1875
St. Anne	1768	1768-1936	<1787	<1787	?	complete by 1787
South-east	1768	1768-1936	?	?	?	?
Praslin	1878	1878-1893	<1787	<1787	91-106	complete by 1875
La Digue	1871	1871-1878	c1800	c1800	71-78	complete by 1875
Aride	1905	1905-1907	1918-50	-	0-18	partial by 1905
Marianne	1893	1893-1905	>1867	>1867	0-38	complete by 1900
Fregate	present	present	1951-82	1995	31	partial by 1900
Alphonse	1962	1962-1965	1950s	>1936	5-15	complete by 1892

predation on fledgelings is clear and the approximately 15 year coexistence corresponds closely to what would be expected if cats were preventing recruitment and causing population senescence. The small size of Alphonse and its complete dominance by coconuts is a most exceptional situation for a magpie robin island and this simple, unstable system would have been extremely vulnerable to perturbation caused by the introduction of any species. For these reasons it is unwise to rely too heavily on conclusions based on what is an unrepresentative situation.

The other islands are more complex and a greater level of disruption would be required to cause extinction. Such large scale disruption may have come from the complete clearance of lowland vegetation accompanying the expansion of the large coconut estates. Although plantations had been established by 1787 on the main islands they occupied a relatively small area until the late 1800s; expansion was occurring by 1867 (Nevill 1868; Newton 1867), by 1910 all lowland forests had been cleared on all the islands. Of the magpie robin islands only Aride, Fregate and La Digue were incompletely cleared with small areas of woodland surviving on the plateaux. On Aride this would have been restricted to 1-2 hectares; too small to support a population. All the La Digue woodland was restricted to the densely settled plateau and extinction is most likely to have resulted from nest robbing by humans (Newton 1867). In contrast, on Fregate, the birds received some degree of protection at this time (Pike 1871). Where lowland forests were cleared extinction occurred within 0-3 years of clearance in 3 cases, 3-18 in one case and in a further 2 cases sometime within 0-38 years of clearance. The Alphonse case is again an exception with magpie robins adapting successfully to plantations, however, it should be noted that they were introduced after the clearance phase of development and that Alphonse, in common with other Amirante islands, had a much lower human population with far less leisure time

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available for nest robbing than on any of the granitic islands. This would be sufficient to allow the species to persist.

Although the data on magpie robin extinction and population changes are too poor to identify definite causes of extinction or long-term patterns they are unequivocal in demonstrating that introduced predators were not significant in the granitic islands. Predation was the most likely cause of extinction only in the extremely simple and unstable environment of Alphonse. Habitat factors, with the additional influence of cyclical weather patterns, are major influences on population cycles and recruitment (of 5 granitic islands with reasonable data extinction occurred in dry phases in 3-4 cases). This area has considerable research potential and may be of paramount importance in field conservation and management projects. Researchers and conservationists would be well advised to monitor population changes, speciation events and general habitat changes in this light. It should also be borne in mind that all robust ecosystems are dynamic and that dynamism and periodicity may mean that systems continuously switch between increase and decline. For insular systems such switching will probably result in populations regularly falling to a crisis point, for, despite our hardest efforts, frequent extinction is an inevitable and natural part of island life.

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